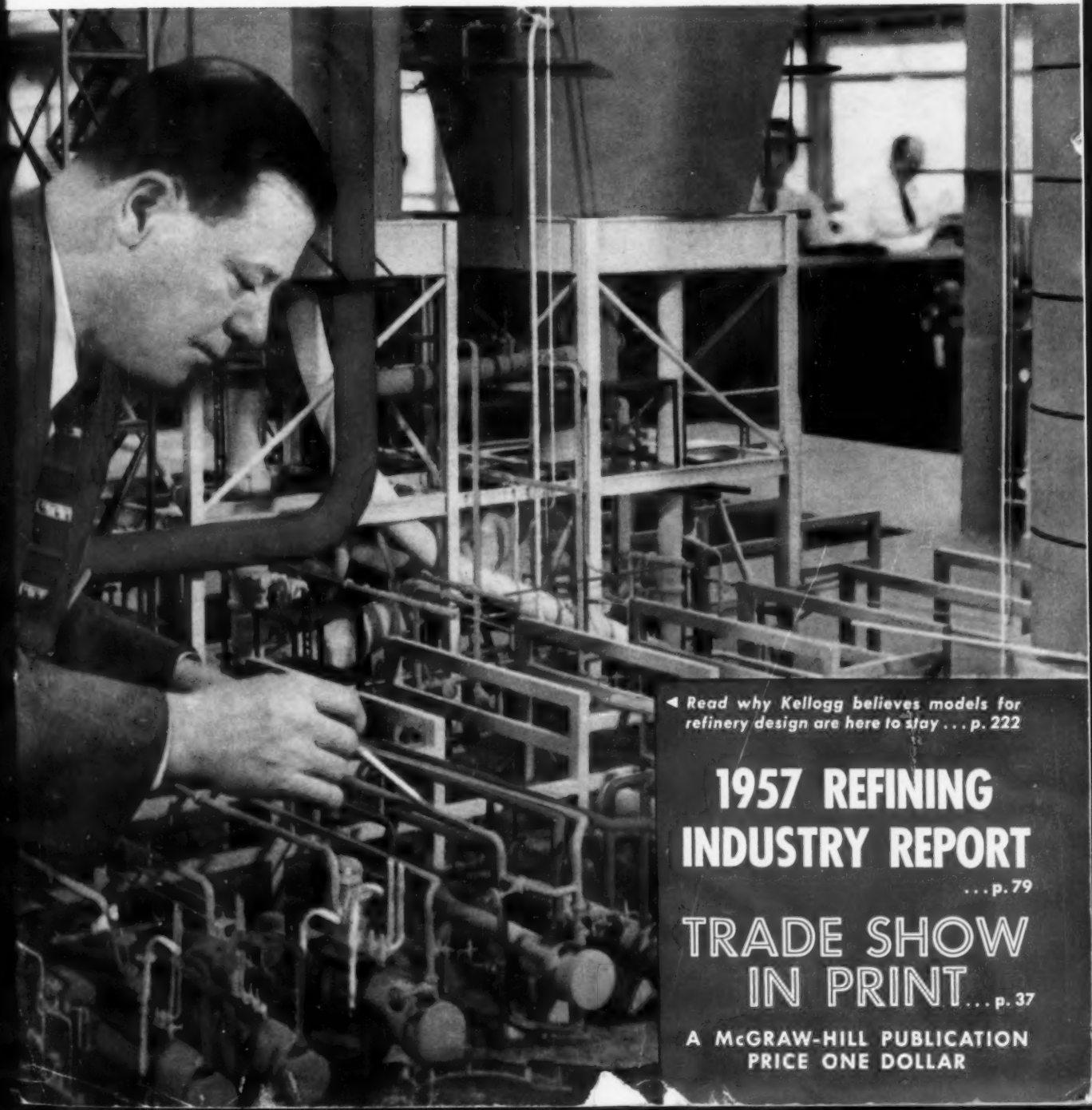
PETROLEUM REFINING
•
PETROCHEMICAL MANUFACTURING
•
GAS LIQUID RECOVERY

MAY, 1957

Petroleum Processing



◄ *Read why Kellogg believes models for refinery design are here to stay . . . p. 222*

1957 REFINING INDUSTRY REPORT

. . . p. 79

TRADE SHOW IN PRINT

. . . p. 37

A McGRAW-HILL PUBLICATION
PRICE ONE DOLLAR

PETROLEOS MEXICANOS

Gas Processing Plant

REYNOSA, MEXICO

Below the Rio Grande, near Reynosa, in Tamaulipas, Mexico, Petroleos Mexicanos has recently completed this major gas processing project designed to process 300 million cubic feet of natural gas daily gathered from numerous fields within an area of about 400 square miles. About 8,000 barrels per day of fractionated products, including propane, butanes, motor fuel, naphtha and kerosene will be produced.

Engineering design and procurement of equipment was entrusted to Hudson, and the satisfaction of our client is attested by a current contract for a similar but even larger project for Petroleos Mexicanos on the Isthmus of Tehuantepec.

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OIL AND GAS PROCESSING PLANTS

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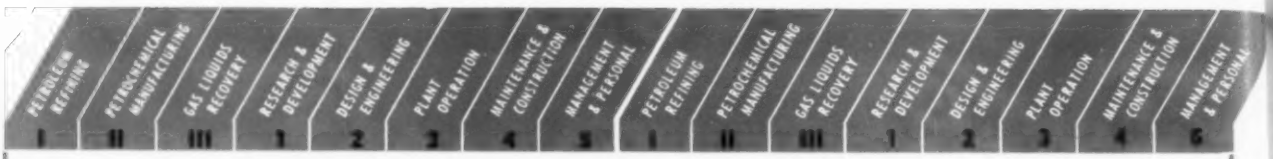
(To obtain more data on advertised products see page 280)



THIS MONTH'S READER'S BONUS

Petroleum Processing's 1957 Refining Industry Report

74 pages of useful, permanent reference information, in three sections:

- **Complete Refinery Directory,** for the United States and Canada, including crude unit and principal process unit capacities, volumes of principal products, geographical locations, and mailing address for each of 359 plants, as well as key personnel, geographical location, and mailing address for all company home offices ..... **p. 81**

- **Glossary of Refining Process,** including a complete index, 74 schematic flow diagrams, literature references, and a helpful coded cross-reference system enabling you to find which design, engineering, and construction companies can furnish specific services for each of 168 processes ..... **p. 97**

- **Who's Who in Refining Service Firms,** covering 79 companies with the coded cross-reference system correlating this directory with the Process Glossary ..... **p. 150**

This is must data for your files, regardless of your field of activity in the petroleum processing industries.

ABP ABC
PETROLEUM PROCESSING
A McGRAW-HILL PUBLICATION
May, 1957
Vol. 12—No. 4

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Processing for May, 1957

PETROLEUM REFINING I | PETROCHEMICAL MANUFACTURING II | GAS LIQUIDS RECOVERY III | RESEARCH & DEVELOPMENT 1 | DESIGN & ENGINEERING 2 | PLANT OPERATION 3 | MAINTENANCE & CONSTRUCTION 4 | MANAGEMENT & PERSONAL 5

High yields for Amoco

Amoco's latest, built for high yields, will be getting a 55-60% gasoline yield on crude because of a number of interesting features. Heart of Virginia's first refinery is an efficient combination unit. Turn to p. 216

I 1 2 3 4 5

Do's and don'ts for "Sniffers"

What are the limitations of vapor testers? New conditions in refineries are affecting reliability of these units. Here's the complete story: how they work, how they're calibrated and used, and the important do's and don'ts. By W. A. Bussard p. 228

I II III 3 4 5

Batch process made automatic

Read how automatic control came to a batch propane dewaxing operation, giving Esso Standard Oil Co. at Baton Rouge, La., five big benefits of continuous, automatic process control. By H. B. Breedlove p. 220

I 2 3

Technical tips for you

Today's up-to-the-minute data from operating men and engineers. The fourth in our 1957 series of articles from the popular question-and-answer session of the WPRA fall meeting. See "Distillation, Thermal Cracking, and Coking Problems." p. 233

I 3

COVER STORY

Design models are here to stay

The cover shows the type of model that Kellogg now uses for designing large petroleum and chemical plants. Read why Kellogg will use these models as a regular part of its services, by Harold Kershaw p. 222

I 2 5

The plant that couldn't be built

But it's built and operating, confirming Cosden's confidence in Ultrafractionation. The unusual styrene plant, onstream since February, is making hypercritical separations, Ron Cannon says, and claims two important firsts. p. 226

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SUBSCRIPTIONS are solicited only from executives, supervisors, engineers, and other technical personnel engaged in petroleum and petrochemical research and development, and in the design and engineering, operation, maintenance and construction of petroleum refining, petrochemical processing, and gas-liquids-recovery plants. **Position and company connection must be indicated on subscription orders.**

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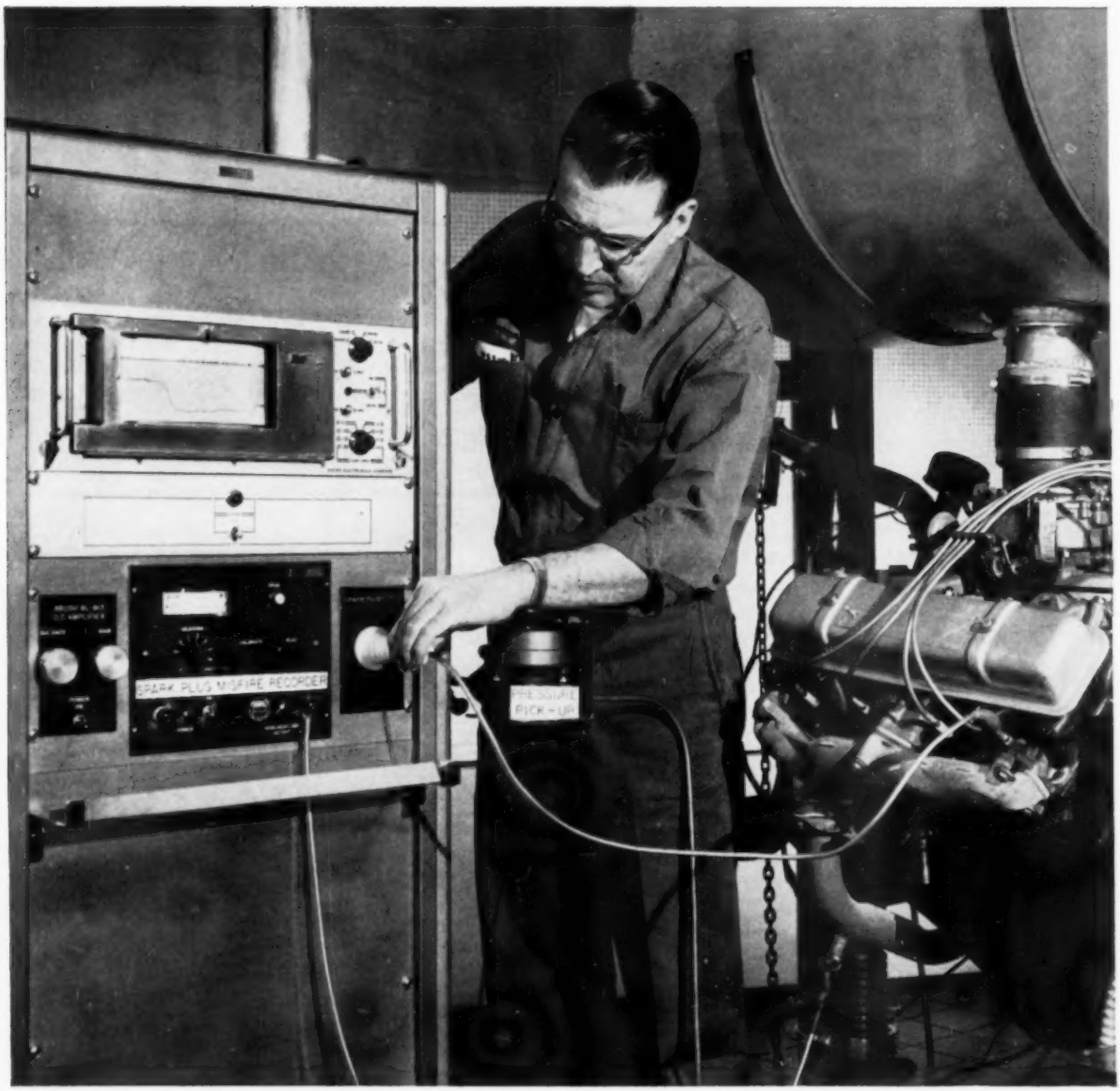
Continue "Reader's guide" on p. 237

HOW TO USE IT:

Your new "Readers' Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest: roman numerals indicate industries; arabic numerals show fields of activity. Secondly, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you—THE EDITORS

Ethyl research gains the spark



Unique instrumentation assures positive detection of misfiring

This Misfire Recorder accurately detects misfiring and records spark plug shunt resistance during a rating test. Pressure pulses in the exhaust system due to misfiring are picked up by a transducer and relayed to the instrument. Spark plug resistance is measured by a built-in megohmmeter.

This type of instrumentation was first applied to the detection of spark plug misfiring by Ethyl Research Laboratories. It has proved so satisfactory that many leading petroleum and automotive companies are now using the same instrumentation in their own laboratories.

(To obtain more data on advertised products see page 280)

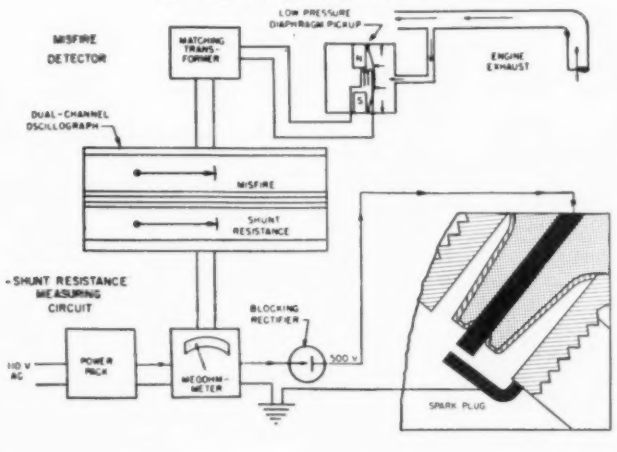
new insight into plug fouling problem

IT'S BEEN EVIDENT for some years that trends in engine design, as well as trends in urban and suburban traffic patterns, are intensifying the problem of spark plug fouling in passenger cars.

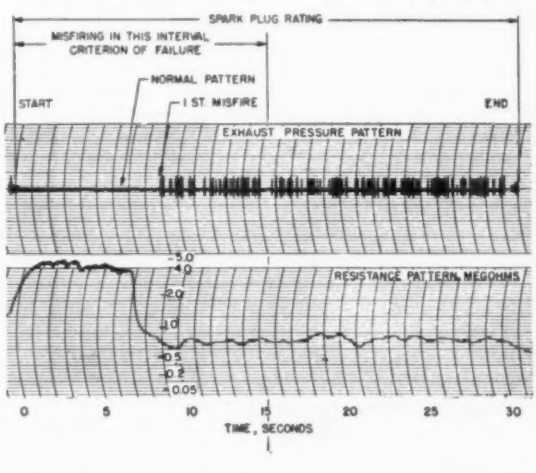
In the process of developing additives to help combat this problem, it became obvious to Ethyl engineers that previous laboratory methods for detecting and measuring spark plug misfire were inadequate. So Ethyl engineers created their own instrumentation—the unique device at the left.

Below is a diagram of the equipment, as well as a picture of the record this instrumentation produces when the transducer and megohmmeter outputs are fed into a dual-channel oscillograph:

Block Diagram of Spark-Plug Instrumentation



Actual Misfire and Shunt Resistance Patterns of a Fouled Spark Plug



How Ethyl Research can help you

Because of its extremely close relationship with both the Petroleum and Automotive Industries over the years, Ethyl Corporation has been able to channel much of its research effort into projects of unusual interest and importance to both industries.

Many new instruments and techniques have been developed and a great storehouse of data on fuel-engine relationships has been produced. For further information, just call your Ethyl Representative.

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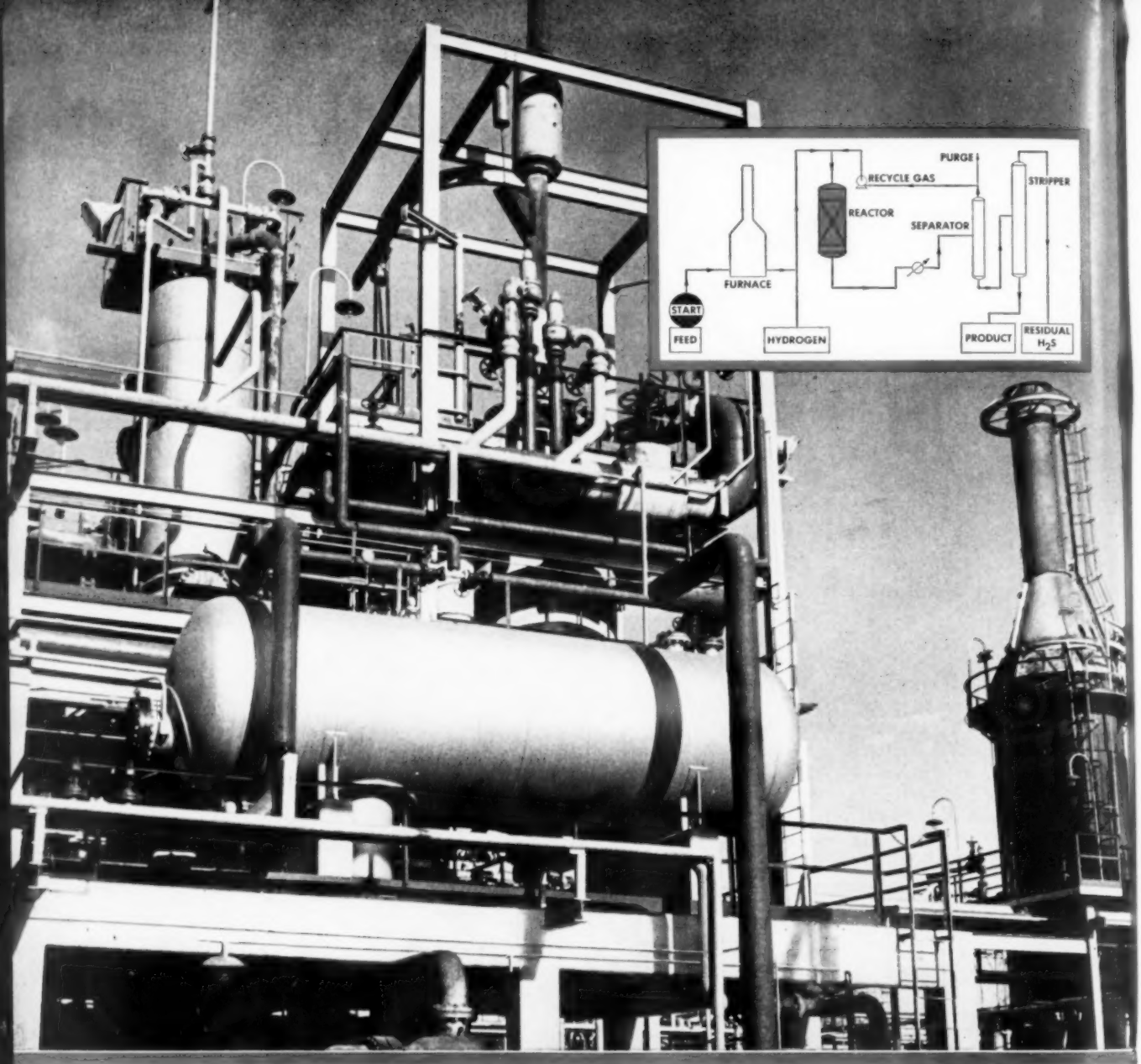

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The process improves product stability, odor, color and other quality characteristics without the disadvantages of chemical or clay treating methods. *Hydrofining* is another achievement of the Esso Research program — 38 years of new process developments made available to refiners around the world.

Hydrofining experience has been gained from commercial units processing a wide variety of feed stocks such as naphthas, distillate fuels, lubes and waxes. This experience plus years of hydrogenation research gives us a unique opportunity to recommend the best design for your plant.

Twenty-three *Hydrofining* installations are on stream; eight more are in the construction or planning stage. Licensees enjoy benefits of continuing *Hydrofining* research. *Hydrofining* can play an important part in helping you process previously unattractive stocks into higher quality products. We would welcome your inquiry.

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Dear Reader...

. . . This is really Bill Bland's job, but he's too busy being an editor. Not that I've had much more time myself, but this must never be a blank page: we owe it to you to keep you advised on our doings.

Why are Bill and the rest of us so busy? Turn to p. 79 for your answer. It is PETROLEUM PROCESSING's 1957 Refining Industry Report—74 pages packed full of up-to-the-minute, useful information you'll be referring to many times in the months ahead.

We literally covered the waterfront—or should I say the oil front—on this project. Every staffer has had a share in the work, and that includes all regular editors, illustration and research people (see listing at left), plus our "girl Fridays," Bertha Herrmann, Pat Egan, and Lu Canaan. In addition, the actual research and writing behind the 50-page glossary of Refining Processes was done by two contributors, George Unzelmann and Chuck Wolf of Ethyl Corp. (see p. 97).

The whole thing got started almost a year ago. Associate Editor Bob Davidson, who had been a refining company process engineer, complained that in spite of all the good oil industry magazines available, he never could find accurate reference information about our industry. More specifically, Bob saw three jobs PETROLEUM PROCESSING could and should do to make the information available. The three jobs were to produce: 1) a complete refining industry directory—where all the plants are, who owns them, who runs them, what they make, how much they make, and what units they use to make it; 2) a complete set of terse, concise descriptions (with flow charts where necessary) of every used and useful process in the industry; and 3) a complete dlirectory of the engineering and other service firms—where they are, what kind of services they provide, and whom to contact for details.

These are the jobs we set out to do, many long months ago. For results, see pp. 79-152.

One final word. We'd be the happiest editors in the world if every one of you would take a few minutes and write us a letter telling who you found useful in this report and what you looked for but don't find at all. This will be extremely helpful in producing better reports of this type in the future.

Bill Uhl

—Managing Editor

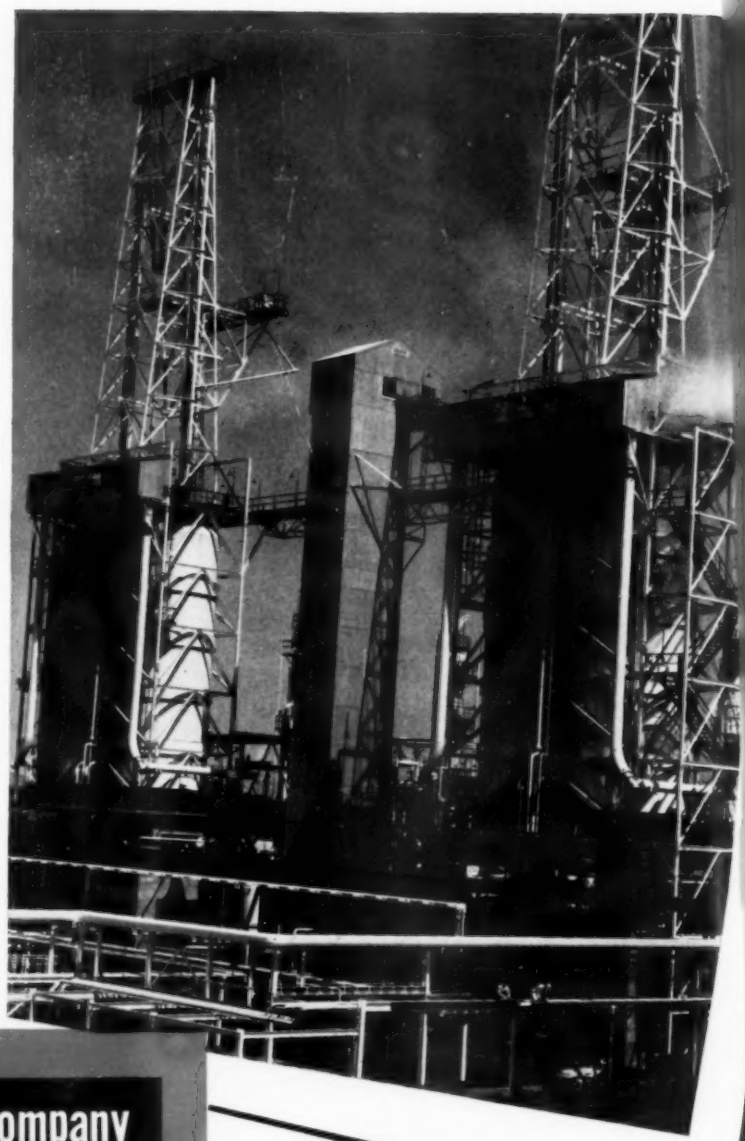
CB&I built Coke Drums . . .

HEART of Twin Coking Units

Four CB&I built coke drums are the heart of two identical coking plants at Union Oil Company's Santa Maria, Calif. refinery. The coke drums are each 18-ft. in diam. by 78-ft. in height and built of ASTM-A-204 plate lined with 7/16-in. Type 405 stainless steel.

The completed vessels were field X-rayed and stress relieved. Stress relieving was accomplished by creating furnaces of the structures and firing large portable oil burners into the vessels to bring them to desired heats.

CB&I's vast experience and complete facilities enable them to engineer, fabricate and erect steel plate structures to the petroleum industry's most exacting specifications. When planning structures of standard or unique design, plan with CB&I. Write our nearest office for complete information.



Twin coking units at Union Oil Company's Santa Maria, Calif. refinery. Both units are equipped with CB&I built coke drums furnished through the Bechtel Corporation.

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WHAT'S HAPPENING

. . . **Today's status of refining industry** is covered in an extensive report in this issue (74 pages, beginning on p. 79). Important highlights of this study are:

- Catalytic cracking still dominates the existing process capacity in today's operating plants, with thermal cracking second, and catalytic reforming third.
- In new construction, however, catalytic reforming and hydrogen processing are both rapidly outstripping catalytic cracking.
- There are 32 idle plants in the United States today, with an estimated shutdown capacity of 110,000 b/d, and two in Canada of about 1,000 b/d capacity.
- Besides these completely shutdown plants, there is approximately 225,000 b/d of temporarily idle capacity in the U.S. in existing refineries.
- Eight U.S. plants, shutdown in recent years, are now being dismantled.

In demand, stocks, trends

	1957 to Apr. 19	1956 All Apr.	% Change
Runs to stills	7.810	7.501	+ 4.1
Demand			
Gasoline	3.939	3.947	—
Middle dist.	2.243	1.989	+12.8
Residual	1.661	1.644	+ 1.0
Stocks			
Gasoline	201.945	189.775	+ 6.4
Middle dist.	92.580	80.898	+14.4
Residuals	36.943	32.582	+13.4

Figures are in million b/d, API data

For more details, turn to p. 275, **this issue**

In refining

. . . **Atlantic Refining Co.** will build a 2100 b/d alkylation unit at its Port Arthur, Texas, refinery. Completion is expected by spring, 1958. Product will be used in motor gasoline.

. . . **British American Oil Co. Ltd's** 20,000 b/d refinery planned for Vancouver, British Columbia, Canada, will have cat cracking, cat reforming, and alkylation. Canadian Kellogg Co., Ltd., will build the refinery, scheduled for completion by late 1958.

. . . **Cal-Mex Oil & Refining Co.,** with plans for a 20,000 b/d refinery in the San Diego, Calif., area (PP, 4-57,p.9), is now free to work toward an arrangement with a major American oil company. Vereinigte Petroleum Werke has released its position with Cal-Mex.

. . . **Cit-Con Oil Corp.** plans a $4-million expansion at its Lake Charles, La., refinery. Paraffin wax production will be increased 25% and light oil production, 20%. Expansion will be in the plant's cooling tower, MEK dewaxing, vacuum distillation and furfural units.

. . . **Clark Oil & Refining Co.** will have Procon, Inc. build a 12,500 b/d UOP-designed cat cracker at Clark's Blue Island, Ill., refinery. Completion is scheduled for early 1958.

. . . **Continental Oil Co.** will build a 3500 b/d cat reformer at its Wichita Falls, Texas, refinery as part of a $1.5-million modernization program to start this summer at the 9500 b/d plant.

. . . **Gulf Oil Corp.** has bought a minority interest in Callery Chemical Co., which is building a $38-million plant at Muskogee, Okla., to make "Hical," a high energy fuel (combination of boron, carbon and hydrogen) for the Navy.

. . . **Humble Oil & Refining Co.** plans a new gas purification plant (using DEA and water scrubbing) to purify 2,770,000 cu ft/hr of refinery gas streams at its Baytown, Texas, refinery. Girdler Co. will design the plant under subcontract from M. W. Kellogg, which is doing other work there.

. . . **Imperial Oil Ltd.** has received final approval for its $17-million refinery expansion at Calgary, Alberta, Canada (PP, 3-57,p.9).

. . . **Irving Oil Co. Ltd.** is considering a refinery in the Maritime Provinces of Canada. Possible sites are St. John, New Brunswick, and Halifax, Nova Scotia.

. . . **Salt Lake Refining Co.'s** North Salt Lake, Utah, refinery has contracted for Fluor Corp., Ltd. to increase the crude still capacity by 3000 b/d, giving a total of 43,000 b/d.

. . . **Phillips Petroleum Co.** has plans for two cat reformers. A 3700 b/d unit (by Procon, Inc., for spring 1958 completion) will be built at the Woods Cross, Utah, refinery. A 16,000 b/d unit (by Fluor Corp. Ltd. for spring 1958 completion) will be built at the Sweeny, Texas, refinery.

. . . **Shell Oil Co.** will build a desulfurized-Platformer at its Norco, La., refinery. The "multimillion" dollar unit is due onstream by the summer of 1958.

. . . **Esso Research & Engineering Co.** plans a large-scale technical computing center, using an IBM 704 scientific computer to be delivered in December. Initial location will be in Linden, N.J., but if Esso

Research's Florham Park, N.J., plans materialize (PP, 4-57, p. 9), the center would be moved there in about three years.

. . . **Other new construction projects,** indicated by recent fast tax write-off approvals, are:

- Phillips Petroleum Co., Kansas City, Kans., $6,525,000 for a 6200 b/d alkylation unit and cat cracker modification.
- Socony Mobil Oil Co., Inc., Buffalo, N. Y., $2,890,000 for a 9000 b/d cat reformer.
- Delhi-Taylor Oil Corp., Corpus Christi, Texas, $685,000 for crude topping unit expansion.
- Esso Standard Oil Co., Everett, Mass., $4,775,000 for a 7200 b/d cat reformer.

In gas liquids recovery

. . . **Tennessee Gas Transmission Co.** plans a new gas liquids recovery plant near Lovington, Texas, to produce about 43,000 gal/d of natural gasoline, propane and butane. An absorption process will be used to process 10-million cu ft/day gas. Operation is scheduled for early 1958.

. . . **Pan American Petroleum Corp.'s** Stano gasoline plant at Ulysses, Kans., has been renamed the Ulysses gasoline plant, effective April 1, 1957. Stano was a shortening of Stanolind, the name of the oil producing firm before it became Pan American during Feb.

. . . **Sinclair Oil & Gas Co.** is installing a desulfurizer and dehydrator at its Gas Products Plant No. 23 in the Hulldale field, 12 miles northeast of Eldorado in Schleicher County, Texas.

In petrochemicals

. . . **Allied Chemical & Dye's** General Chemical Div. has contracted for Girdler Co. to design and build a sulfur recovery plant at Linden, N.J. The 60 t/d sulfur plant will use hydrogen sulfide from the Bayway, N.J., refinery of Esso Standard Oil Co. Completion is scheduled for late 1957.

. . . **Amoco Chemicals Corp.** has given a contract to Blaw-Knox Co. to build a plant near Seymour, Ind., to manufacture a new smokeless starter cartridge for jet aircraft engines. Production is scheduled to start late 1957.

. . . **Carbide and Carbon Chemicals Co.** will double acrylonitrile production at its Institute, West Va., plant by the second quarter of 1958.

. . . **Ethyl Corp.** has unveiled details of its new tetraethyl lead process. The key to the process is the use of organometallics permitting the formation of TEL from some surprisingly inactive lead compounds.

. . . **Delhi-Taylor Oil Corp.** will start marketing benzene, toluene and xylene by mid-1957 from its Corpus Christi, Texas, refinery.

. . . **Dow Chemical Co.** is building a second synthetic glycerine plant at its Texas Division, Freeport, Texas. To double present glycerine capacity at Freeport, the plant is scheduled for completion March 1958.

. . . **Du Pont Co. of Canada, Ltd.** will spend about $7.5-million to expand its nylon plants in Kingston and Maitland, Ontario, Kingston facilities will be converted from nylon tire cord to make staple fiber and yarn.

. . . **Esso Research & Engineering Co.** has acquired a license to produce butadiene, butenes, and other light olefins by the Houdry Process Corp. Dehydrogenation process.

. . . **Naugatuck Chemical Div.,** U.S. Rubber Co., is building a $7-million plant to make Kralastic plastics at Baton Rouge, La. Raw materials will be butadiene, styrene and acrylonitrile. Walter Kidde Constructors, Inc. will do the design and engineering, Louisiana Industrial Services of Baton Rouge will do the field construction, to be completed late this year.

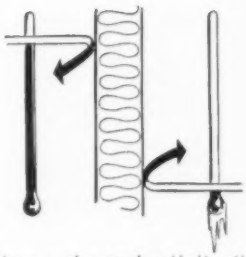
. . . **Petroleum Chemicals, Inc.'s** new ethylene plant at Lake Charles, La., has been designed, and will be built by Lummus Co. The new unit will expand Petroleum Chemicals' ethylene production by 50%, to a total of 300-million lb-yr. Completion is scheduled for late 1957.

. . . **Shell Oil Co. of Canada Ltd,** is building a $1-million epoxy-type resin plant alongside its Montreal East, Quebec, Canada, chemical plant. Construction of the Shell-designed plant will be by Refinery Engineering Ltd. of Toronto.

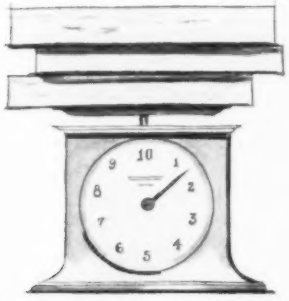
. . . **Wyandotte Chemicals Corp.** plans a new oxide products plant for Wyandotte, Mich. The $3-million plant will make "multi-million lb/yr" of polyethers for use in polyurethanes, and nonionic surface-active agents, the Pluronics and Tetronics. Completion is scheduled for late 1957.

. . . **B. F. Goodrich Chemical Co.** will build a $5-million plant near Henry, Ill., to produce specialty organic chemicals, including antioxidants for use in the petroleum, rubber, plastics and other industries. Production is scheduled to start early 1958. Blaw-Knox Co. is the general contractor.

. . . **Two sulfur-from-natural-gas plants** will be built in the Calgary, Alberta, Canada, area when and if gas production there warrants. Jefferson Lake Sulfur Co. would build the first plant (about 350 long t/d sulfur) at a gas field under development by Mobil Oil of Canada Ltd., on Calgary's eastern limits.



Low thermal conductivity (k) permits use of lesser thicknesses!



Lightweight Fiberglas blocks offer economical installation, easy maintenance!

Dimensionally stable, inorganic fibers of glass will never rot, corrode, settle!

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. . . distributed by approved Fiberglas distributor-contractors . . . offer the most versatile family of plant insulations available, in the widest range of shapes, sizes and thicknesses for every type of industrial application. With new *pink* Kaylo-*20* insulation serving the extra-high temperature ranges, you can now order—from *one* reliable supplier—complete insulation coverage *from lowest sub-zero to 1800°F.!* See *Sweet's Files, Chemical Engineering Catalog* or *The Refinery Catalog*. Or write: Owens-Corning Fiberglas Corporation, Dept. 185-E, Toledo 1, Ohio.

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Specify

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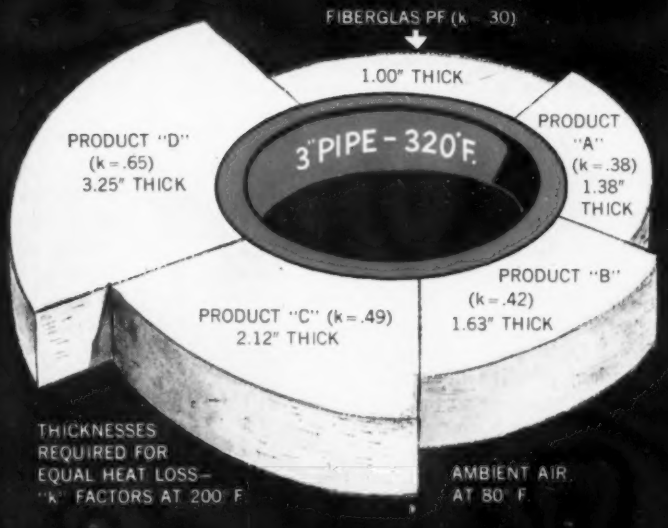
Industrial Insulations


FIBERGLAS PF (k = .30)
1.00" THICK
PRODUCT "D" (k = .65) 3.25" THICK
3" PIPE - 320°F.
PRODUCT "A" (k = .38) 1.38" THICK
PRODUCT "B" (k = .42) 1.63" THICK
PRODUCT "C" (k = .49) 2.12" THICK
THICKNESSES REQUIRED FOR EQUAL HEAT LOSS— "k" FACTORS AT 200° F
AMBIENT AIR AT 80° F

for insulating efficiency!

(To obtain more data on advertised products see page 280)

The second plant (300 long t/d sulfur) would be built by Shell Oil Co. of Canada Ltd. on its Okotoks gas field, about 15 miles south of Calgary.

. . . **Texas Gas Corp.** plans to expand its refining and gas processing plant at Winnie, Texas, to produce raw materials for the area's chemical plants. Texas Gas is also considering new plants to make ethanol and extract pure cyclohexane.

In foreign operations

. . . Britain and Europe

. . . **Deutsche Shell A. G.** plans to spend $63.1-million for a 14,000 b/d refinery in Godorf near Cologne. Construction will start this fall.

. . . **Esso A. G.** will invest between $11.8-million and $14.3-million to expand its 40,000 b/d, Hamburg, Germany, refinery during 1958-60 to give a total capacity of 53,000 b/d.

. . . **Petrofina's** West German and Italian refinery plans have been scaled down. The Duisburg plant, to be built by Purfina Mineraloelraffinerie AG, a wholly-owned subsidiary, will be for 20,000 b/d instead of 60,000 (PP, 4-57,p.12). The Rome refinery (50% Petrofina, 50% Ente Nazionale Idrocarburi), to be built by Raffineria Di Roma, will be for 30,000 b/d instead of 60,000 b/d (PP, 3-57,p.12).

. . . **Shell Chemical Co. (UK)** plans to spend $87-million to expand petrochemical production at its Partington, England, plant 4 or 5 times in the next 5 years. Output will be doubled by 1958.

. . . **Gottlieb Duttweiler,** head of the Migrol system of independent gasoline outlets in Lower Saxony, Germany, is negotiating to build a refinery at Emden.

. . . The East

. . . **Turkey's planned Istanbul refinery** (PP, 2-57,p.12) to be built by Socony Mobil, Caltex, Shell and British petroleum, is scheduled to go onstream in 1960 at a site to be selected by mid-1957. Initial process units will include crude distillation and cat reforming.

. . . **The South Australian government** will ask several of the oil companies operating in Australia to consider building a refinery on the Lefevre Peninsula. At present, there is no refinery there, and 1958-59 demand is expected to exceed 20,000 b/d.

. . . **Nippon Steel Tube Co.** has a tentative agreement with the Thailand government to build a 15,000 b/d refinery near Bangkok. The refinery would be Thailand's first.

. . . **Mitsubishi Chemical Industry Co.** will have technical assistance from Chemstrand Corp. for building a plant at Fukuoka to make Acrilan. The $5-million plant will make 500 t/mo of HCN and 600 t/mo of acrylonitrile. Completion is scheduled by Sept. 1958.

. . . **Imperial Chemical Industries** will build a $4.2-million polyethylene plant at Sydney, Australia, aimed at saving Australia $2.8-million/yr in imports.

. . . **Befu Chemical Co., Ltd.** will have Chemical Construction Corp. design a 100 t/d ammonia plant (ultimate capacity) for the southern end of Honshu Island. The Texaco partial oxidation process for oil will be used for gas generation.

. . . **The Stanvac refinery** at Bombay, India, plans to increase output over 1956's 28,000 b/d, and will start "certain manufactures," believed to be fertilizers from refinery byproducts.

. . . Latin America

. . . **The Venezuelan** government plans to build a "commercial sized" refinery as part of its National Petrochemical Industry at Morón, on the Caribbean coast. Construction is due to start late next year.

In transition

. . . **Republic Oil Refining Co.** has been merged with its parent company, Plymouth Oil Co., but will continue operations as a refining and marketing division of Plymouth.

In markets and prices

. . . **The backspin of the Suez crisis** is still being felt as the refining industry goes into summer. Broadly, it means that the price position looks stronger in seaboard areas than at inland locations. But normal, seasonal declines in heating oils probably will come to the East by the time this page is set in type.

Refiners in the best position are those along the Gulf Coast, for many of them have heating oil sales on their books well into the "off" summer season.

Toughest spot continues to be the upper Midwest. Gasoline prices don't look strong there. And heating oil offerings at 9.25¢, f.o.b. Wood River, continue to plague the Chicago transport market.

Refiners have probably been a little slow to cut back on output as the Suez demand wanes. The result has been increased pressure to find outlets, particularly "controlled" outlets, such as branded retail stations, contract barge customers, and the like.

But with all the pressure to move oil, the feeling is that crude prices will hold. Discounts may be rife in many areas, but—it is thought—not heavy enough to break the structure.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

385 Madison Avenue — New York 17, N. Y.

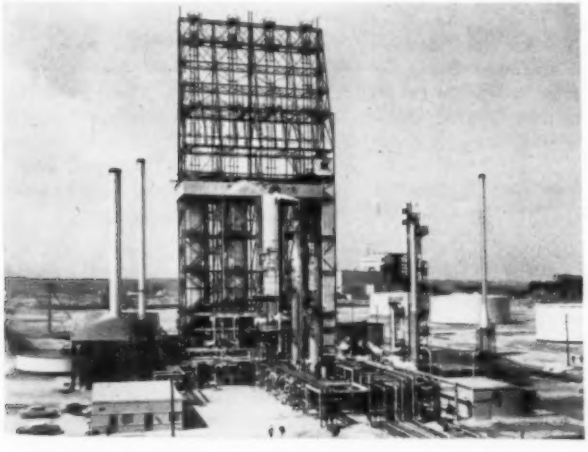
NEW AMOCO DELAYED COKER EXCEEDS EXPECTATIONS...RUNNING MOST DIFFICULT CHARGE STOCK

Lummus designs, engineers and constructs unique 4-coke-drum, 600 ton-per-day unit. Designed for vacuum bottoms containing 25% Conradson Carbon.

A Delayed Coking Unit which handles the heaviest feed ever charged is now in operation at the new Yorktown, Virginia refinery of The American Oil Company.

The unit has been in continuous operation since the initial firing on January 30, 1957, surpassing all guarantees of capacity of charge stock and product specifications, and has been formally accepted before completion of this run.

The fractionating tower produces light and heavy gasoline and light and heavy gas oils meeting all rigid Amoco specifications for the production of high octane unleaded gasoline. Coke produced meets client's specifications for pulverizing for use in boilers.



This delayed coker at Amoco's new Yorktown, Va. refinery handles the heaviest charge on record. Four coke drums measure 17'6" x 75' tangent to tangent. Refinery will help supply unleaded "Amoco-Gas" to an 18-state market.

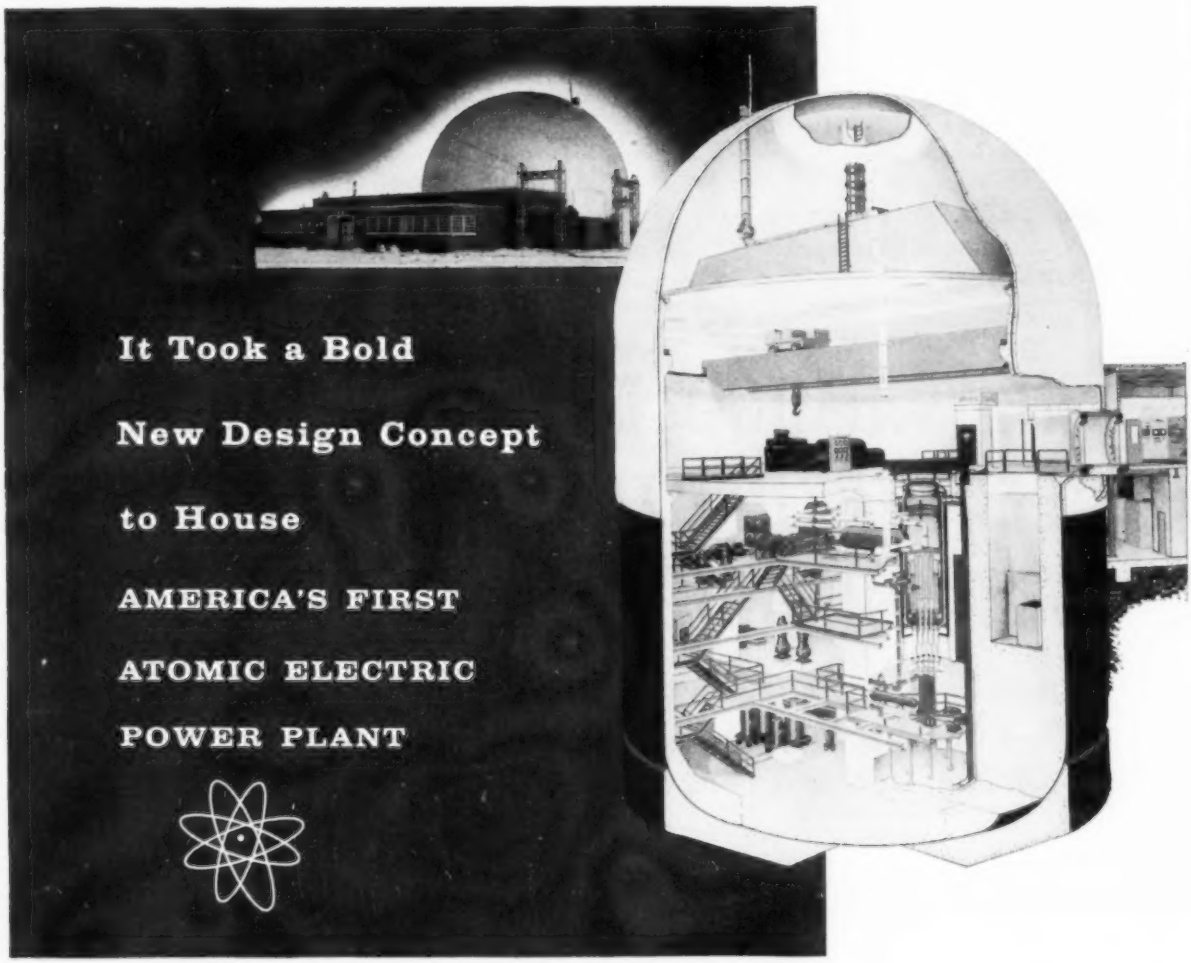
Evaluation of charge stock in Lummus laboratories and pilot plants supplied the information for special design features that were incorporated into the heater—the heart of the process—and other critical equipment, to handle the heaviest charge stock on record. The unit was designed for a charge mixture of vacuum reduced crude with 25% Conradson Carbon, an API gravity of 6.1°, and an SFS viscosity of 6,000 at 210° F. It was also designed to process a variety of stocks at different recycle ratios to meet required flexibility.

The new unit, based on pilot plant work at Lummus laboratories, was designed, engineered and built by The Lummus Company, and was completed 10½ months after the piles were driven.

Lummus has designed much of America's coking capacity — 10 units — combined capacity of over 120,000 barrels per day.

Lummus engineers will be glad to show you how your next project can be designed to produce a maximum return on your capital investment.

THE LUMMUS COMPANY, 385 Madison Ave., New York 17, N.Y. *Engineering and Sales Offices and Subsidiaries:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Engineering Center:* Newark, N. J.



How do you house an atomic electric power plant? Dig a hole five stories down. Erect a giant ten-story welded steel "containment vessel." Seal it off air-tight, and you have one of the largest pressure vessels man has ever been called on to build.

That's the story, over-simplified, of the unique housing required for America's first nuclear-powered electric plant, the Experimental Boiling Water Reactor, at Argonne National Laboratory, Lemont, Illinois.

In our practical, efficient world of engineering, there is a sound structural reason for the unusual dome-shaped building, now recognized by everyone as the symbol of atomic-power-for-peace.

Radioactive steam and gases must be contained within the system. The precautions necessary demanded an air-tight building, 80 feet in diameter by 119 feet high.

This giant welded steel structure, designed to withstand a pressure of 15 pounds per square inch above gage pressure, was made concave throughout, with a semi-ellipsoid bottom and a hemispheric top.

Upon completion, the half-million cubic foot shell was tested for air-tightness. Never before had so large a welded structure required such thorough testing against air loss.

Graver's skills, backed by a century of experience, were called upon to fabricate, erect and test this unique steel structure.

Graver's research department devised the special air-tightness testing procedures. Graver fabricated all sealing devices—the access air-locks, bulkheads and doors, and the two water-demineralizing systems. It also furnished the saucer-shaped 15,000 gallon water tank suspended under the dome.

This application of Graver's skills in the fabrication and erection of America's first atomic power plant is indicative of Graver's readiness to help you fulfill your plans for the future, no matter how unusual or exacting the requirements.

Building for the Future on 100 Years of Craftsmanship in Steels and Alloys

GRAVER TANK & MFG. CO., INC.

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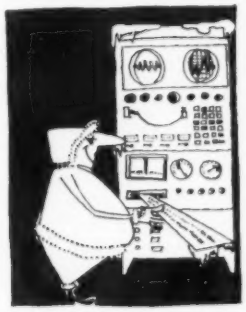
GRAVER

(To obtain more data on advertised products see page 280)

The frigid digit is coming—cold computers to do hot jobs

YOU MAY not recognize tomorrow's computers. Scientists are changing its size, shape, and now perhaps, its temperature. It looks as though recent low temperature research will pay off in more efficient computers.

In 1911, scientists experimenting with extremely low temperatures—down to within 6° or closer to absolute zero—discovered that some metals have little or no electrical resistance at these temperatures. The metals affected were called superconductors. But beyond the peculiarity of this phenomenon, there seemed to be little practical use for this strange behavior of mercury, tin, lead, aluminum and other metals.



However, research work by Dudley A. Buck at MIT and development work by Arthur D. Little, Inc., promise to put this phenomenon to a very practical use. Specifically: to reduce drastically the size of complex computers. How? By replacing vacuum tubes and even transistors with a small coil of wire wrapped around a small strand of wire—so small that 100 of the devices will fit into a thimble.

Labeled cryotron, from the Greek word **kyros** (meaning "freezing cold"), these electrical switches will cut "off" and "on" the switching currents used in many data processing machines. Below a certain temperature near absolute zero, the straight wire component of the cryotron conducts a current with no resistance. When another current is pushed through the control winding, this property of superconductivity is destroyed and resistance returns to the piece of straight wire.

Thus, current in the control wire can completely cut off current in the straight wire, permitting it to function as a minute electrical switch. By connecting up to 25,000 cryotrons in various circuits, a tiny computer can be built—so small that all the switching elements will occupy only 1 cu ft.

Several problems must still be solved before the minute computer is a reality. For instance, the need to maintain low temperatures with liquified helium (at a boiling point of −268.9°C) requires special refrigeration equipment. Ten years ago this low temperature would have been an impossible operating condition. But today this temperature is relatively easy to achieve. Although the refrigeration equipment will occupy some of the space saved by the cryotrons, the power required to operate the total computer unit promises to be drastically reduced.

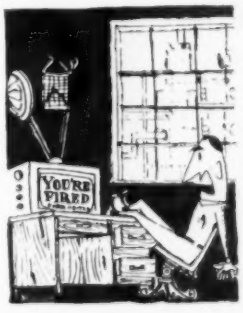
Another problem is the slow speed of the present cryotron switch, faster than relays but far slower than vacuum tubes. Some feel it is too slow for critical computer work, but by using other types of alloys it is felt this problem can be licked. Alloys of vanadium-palladium can alter the resistance of the straight wire (and thereby its sensitivity) and decrease the inductance of the coil. Both of these steps will improve the operating speed.

But whatever steps are taken to solve these minor problems, it looks like a short time until basic research makes the frigid digit a reality. —W.A.B.

"Miss Jones, take a TV message"

TELEVISION tomorrow promises to help out in office work as well as in strictly industrial tasks, if the work being done at Stanford Research Institute is any indication.

Development work for the A. B. Dick Co. at SRI has already produced a prototype TV network for transmission and reproduction of office paperwork or line drawings—and perhaps even for photographs. The system can duplicate 17,000 typewritten characters per sec—the equivalent of three typewritten pages/sec—from original text.



The system is an ingenious use of electronics, both for duplication and transmission. This is how it works. A spot of light, only 0.006 in. in diameter, scans the original document. Flashing across the page at a rate of 1 in. per 30 microseconds, the spot of light makes 1700 horizontal sweeps in ⅓ sec.

The light reflected from the document is received by phototubes. As the scanning spot sweeps across white pages, the electron flow is high. When it is reflected from black portions of printing—which absorbs the light—the electron flow is low.

This signal is then transmitted to receivers through coaxial cable, or broadcast as a TV signal, and received and amplified at distant locations. When the transmitted beam strikes a dark spot, a small electric charge is deposited at the receiver on special copy paper. After 1700 successive scannings of this kind, enough electric charges are deposited on the copy paper for electrical reproduction.

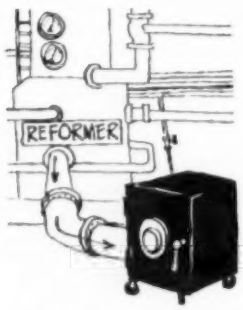
This is done by pulling the copy paper past a faceplate where it is mechanically dusted with black

powder that clings to the charges on the paper. The powder is then heated and pressed into the paper for a permanent record.

At present, the device prints from a 35-mm film onto a continuous ¾-in. tape. But future equipment will permit duplication directly on sheets of 8½-by-11 in. paper. When this is perfected, it will then be possible to have Miss Jones "get that message on the TV immediately to all plants." —W.A.B.

Tomorrow's moneymakers—reformer-made solvents

THE PETROLEUM processing industry will soon find itself with a fast-growing demand for its sizeable production of reformer-made solvents —particularly xylenes—as raw materials for chemicals. When this happens—and indications are that it is just around the corner—refiners will have the happy choice of choosing between using these aromatics in motor fuels or diverting them into the more profitable petrochemical market.



The big reason for all the interest in xylenes is this:

—the estimated production of 96.1 million gal/yr of mixed xylenes will bring about $31.7 million at present modest prices, mostly as an octane booster in motor fuel or as a solvent.

—if separated into its isomers, the xylene would be worth about $79 million, at present prices.

—if made into its respective phthalic acids, this xylene production would blossom into products worth $197 million.

In short, the refiner can upgrade a 3-4¢ product to one worth 12-13¢, or—by one more step—to one worth 25¢ per lb.

The prospect of these sizeable bonuses is stimulating interest in the possibilities of reformer aromatics and in the uses and processing of the phthalic acids from xylene. At least four companies—Du Pont, Hercules, Oronite, and Standard Oil (Calif.) are producing acids from xylene isomers in commercial plants. Polyester fibers (Dacron) and film (Mylar) are notable successes in the xylene family tree. In addition, Cosden Petroleum recently announced the successful separation of ethylbenzene from a mixed xylene stream—effluent from its reformer—as a charge stock for its new styrene plant.

But signs indicate that there is more in store for the xylenes. Extensive research is aimed at finding new uses for the acids, and developing markets in proportion to the expected yield of the isomers and acids from the mixed stream. Some of the possibilities:

—polyamides based on hexamethylenediamine and isophthalic acid.

—films and fibers based on adipic acid and m-xylylenediamine.

—films and fibers based on blends of isophthalic and terephthalic.

—polyesters that employ terephthalic acid rather than dimethyl terephthalate.

Research is also trying to overcome the technical difficulties of converting the xylenes into useful intermediates. One process, developed by Scientific Design, supposedly accomplishes the oxidation of all three isomeric xylenes to their respective phthalic acids without prior separation. Standard Oil (Indiana) plans a commercial plant based on this process.

Because every catalytic reformer turns out xylenes in amounts varying with the charge stock and process, the total production is tremendous. One conservative estimate is that over a billion lb/yr is produced, and only a fraction of that is separated from the heavier aromatics, so it appears that the plant with reformers has a good investment for many years to come. If the scramble for xylenes develops as expected, we may see another offspring of reforming as spectacular as that of hydrogen treating. —R.E.C.

Management tomorrow may look further afield than it does now for its replacements. Two University of California psychologists have concluded that top level men have talents different from those of middle management men, the usual source of replacements for top positions. Top level men are characterized as active, self reliant, candid, and willing to take risks. Middle men have less confidence, often picture themselves as stable and dependable. —A.C.

Gas turbines tomorrow could have an adverse effect on markets for refinery products now that new designs permit use of very low quality fuels (90 Btu/cu ft). U. S. Steel has ordered a gas turbine to operate on blast furnace gases to drive a heavy duty compressor. Key to the breakthrough was handling about 10 times as much gas as usual in the combustor.—A.C.

ORONITE®
MORE AND MORE
experienced oil marketers
are turning to Oronite
...the most versatile
LUBE OIL ADDITIVE
supplier!
and here's why...

Why Oronite is the preferred source for

LUBE OIL ADDITIVES

Custom formulations
Special-performance additives
Complete-performance additives

Engine testing facilities
World-wide distribution
Technical service
Continuous additive research
Retail oil marketing background
Reliable raw material source

Custom formulations

Oronite's rapid growth as a major additive supplier—to marketers of branded motor oils and to compounders of commercial and military oils—is the result of a willingness to formulate to customers' exact needs and specifications. Because of advanced research techniques and modern manufacturing facilities, custom-compounding has been accomplished at progressively lower treating costs. Today, Oronite is supplying over a hundred different additive compounds—having recorded engine tests on hundreds.

Special-performance additives

Many major oil marketers, requiring added emphasis on single performance characteristics in their finished products, specify Oronite's single performance additives. If you want added detergent-dispersant or extreme pressure wear properties, greater resistance to corrosive wear, or special low temperature performance—Oronite can provide you any of these single performance additives. Whatever your needs you will find Oronite willing and capable of answering your requirements.

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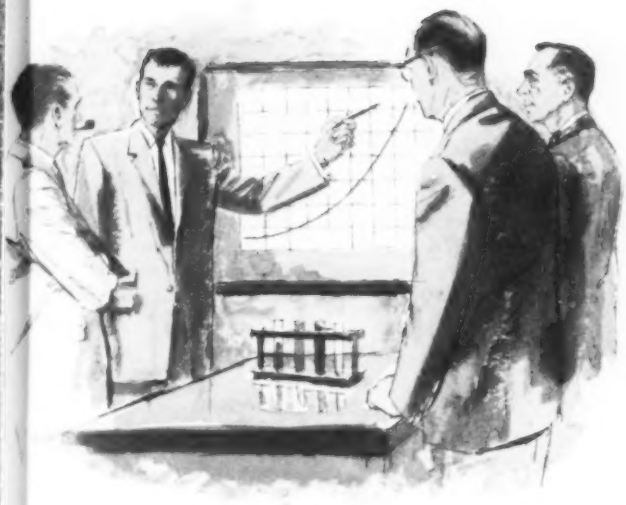
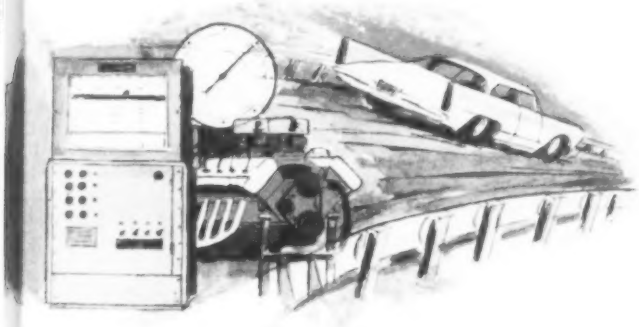


Complete-performance additives

For customers who require "complete-performance" from an additive formulation, Oronite additives impart all the necessary performance characteristics to a motor oil: detergent-dispersant properties, resistance to oxidation, rust protection, corrosion protection, reduced engine wear and engine cleanliness under low temperature operation. Most additives on the market provide some of these qualities but Oronite additive components are balanced to give optimum performance under all types of operation, at no extra cost. Whatever the type of service required of the finished oil or type of base stock available for compounding—you will get better all-around performance with Oronite additives.

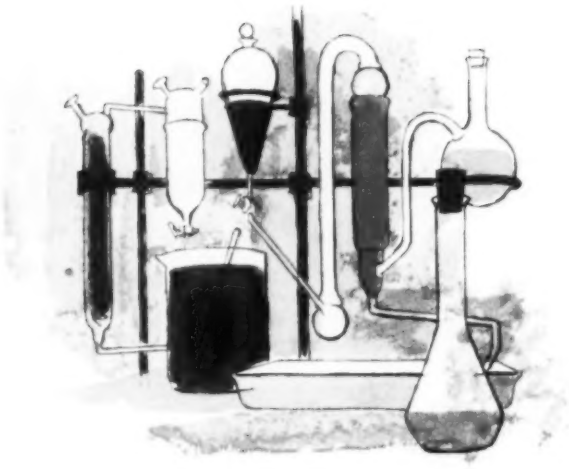


Engine testing facilities

Oronite places unusual emphasis on testing compounded oils, whether for standard approval tests or special tests to prove out specific oil performance properties. Laboratory engine tests are made to establish compounding levels required for various field conditions. These tests are then correlated with actual field operating conditions, thus permitting Oronite to make sound recommendations. Procedures are thorough for testing aviation, diesel and gasoline engine oils.

World-wide distribution and technical service

Wherever you are located you will find field service and technical assistance quickly and consistently available. Your questions will be answered directly, problems solved efficiently and deliveries made on time. Knowing and understanding local marketing conditions in any part of the world, Oronite is in a position of being the most help to you. Why not let our vast experience serve you?

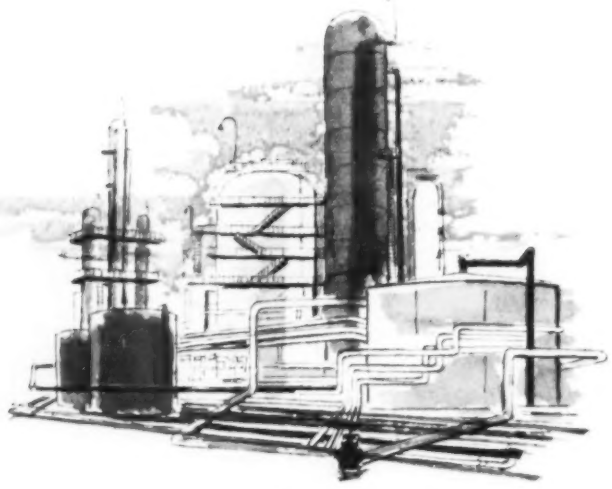


Continuous additive research

The research and testing facilities behind Oronite additives are the most advanced in the nation. With years-ahead additive products being constantly developed and tested, you can be assured that if you do business with Oronite you will be first to have the newest and best in lube oil additives.

Retail oil marketing background

Having close contact plus a long-standing background of experience with customers in oil marketing, Oronite has a first-hand knowledge of the problems and opportunities of the oil marketer. This continuing association enables Oronite to make recommendations with sales and promotional advantages—has helped many marketers gain better sales positions with superior compounded motor oils. Possibly we can show you ways to increase your sales and profits from finished oils. Why not talk it over?



Reliable raw material source

Oronite, with its closely affiliated companies in the petroleum industry, is assured of quality raw materials and continuous supply. A leading manufacturer of petrochemicals, Oronite has the experience and facilities in oils and chemicals to consistently produce the finest additive products—assuring you dependability, maximum performance and fair prices.

Oronite Chemical Company
200 Bush Street, Dept. L
San Francisco 20, California

I would like to hear your complete Lube Oil Additive story.
Please have an Oronite representative call on me.

Name _____

Firm _____ Position _____

City _____ State _____

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20 North Wacker Drive, Chicago 6, Illinois
Carew Tower, Cincinnati 2, Ohio
Mercantile Securities Building, Dallas 1, Texas
714 West Olympic Boulevard, Los Angeles 15, California
450 Mission Street, San Francisco 5, California

European Office
36, Avenue William-Favre, Geneva, Switzerland

LETTERS

More on crude oil index

To The Editor: Mr. Rothbard's "Crude Oil Quality Index" (Jan, p. 68) appears to propose a method for the *evaluation* of crudes, whereas the API gravity basis is a *pricing* procedure. In my opinion, a general method cannot be devised for evaluation of crudes. Neither can the API basis be anything more than a general pricing procedure, providing the potential buyers evaluate the crudes they purchase on a realistic basis which applies to their own specific situation.

The value of a crude to a refiner depends upon: 1) processing route or refinery facilities, and 2) product distribution—sales volume, price, and other factors.

Processing route is frequently changed by installation of new units, remodeling of old facilities, or even by redefining existing capacity through operating experience. For example, a high sulfur crude may be worthless to a refinery with a set processing route. Installation of a Hydrofining unit may effect a complete change in the value of the high sulfur crude.

Yet this crude carries a price tag, probably on the API basis, with an adjustment for sulfur content. There are examples of crudes priced so high above the value to any refinery that they go unprocessed. Even the installation of new tankage may affect the processing route because it will permit the use of otherwise unused processing capacity during some periods of the year.

Product sales distribution is a factor determining the value of a crude to the refiner. In an area where residual fuel is a distress product, for example, the light crudes normally have a higher relative value than the heavy crudes. Price wars on clean products and high prices for industrial fuels result in the heavy crudes having a high demand for jet fuel—and more recently for road asphalts—must be considered in evaluating crudes. And each refiner must evaluate his own situation. Product sales distribution is an ever-changing factor in any refinery operation that requires constant revisions to crude values.

Values of crudes must always be compared on a delivered basis. Varying transportation costs because of distance and methods of delivery will, or should, affect the field price for the crudes. Where transportation costs on two or more different crudes are equal, and API prices may be the determining factor in choice of a single crude.

The producer may actually have priced himself out of business without realizing that the API pricing method is erroneous. Similarly, the new "Quality Index" method may have the same result.

Evaluating the proper pricing of crude oils is a highly complex problem. This is particularly true when all the factors mentioned above change and when a change in one factor effects a change in another.

One refinery competitor can effect a change in the whole situation of other refineries. For example, a residual fuel surplus in California was changed by the installation of several coking and cracking units. Even a new crude discovery in one area can result in a drastic change in the values of other crudes.

It appears that the solution to crude pricing should be accomplished by each refinery, employing qualified technical personnel to obtain proper evaluation of available crudes; then let the law of supply and demand be the control.

There is doubtful value in the pricing of crudes by the producer on a set formula regardless of the factors the refiner faces: location, processing route, and product distribution. It also appears doubtful that an "evaluation formula or procedure" can be devised which will cover all refinery situations adequately.

Milton E. Danitschek
Utah Oil Refining Co.
Salt Lake City, Utah

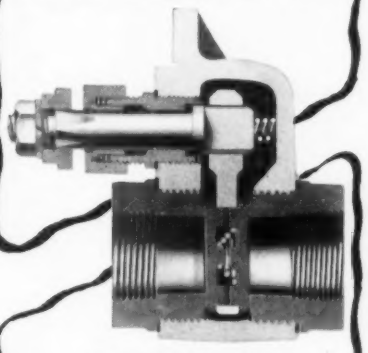
Author Rothbard replies:

Calling the API gravity method a "pricing process" is interesting because it precludes factors discussed in this letter—production, distribution, consumption, and detailed crude breakdown for suitability in specific refinery equipment.

The API gravity method offers a single number based on volume content of the gasoline fraction in the crude oil, simplifying buying and selling transactions. Mr. Danitschek emphasizes this point in his sixth paragraph where he states that when transportation costs on several crudes are equal the API prices may be the determining factor in choice.

The weakness in the API gravity method lies in the fact that 1) it does not consider the volume content of the other fractions in the crude, and 2) there is no satisfactory relationship

FULL-FLOW
Okadee
VALVES
NON-LUBRICATED



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You can select Okadee Valves for flow by pipe size — and get full-flow and positive shut-off with virtually any liquids and gases.

Quick-opening, metal-to-metal disc valves and seats require no lubrication—virtually no maintenance for hundreds of thousands of operations . . . Real valve *performance* and *service*.

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(To obtain more data on advertised products see page 280)

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WILL ACHIEVE
lower
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AND
operating costs
AT THEIR
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process

The Alumicoat Molten Aluminum Process will substantially reduce down time and expense for repairs and replacements by preventing high temperature hydrogen-sulfide corrosion and scaling in hydro-desulfurizing equipment.

In addition, costs will be reduced further by the use of low cost, low alloy steels which, when "ALUMICOATED", obtain the necessary resistance to high temperature hydrogen-sulfide corrosion.

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between the API gravity of the crude oil and its gasoline content. This second point can be checked by tabulating crudes shown in Table 3 of my January article in order of descending API gravity—say from 50.1 down to 31.3—and showing in the same tabulation the corresponding gasoline contents of each crude. I did this with 18 crudes from Oklahoma and found only four showed a good API gravity-gasoline content relationship. The other 14 showed little or no correlation.

The Quality Index method includes yields from five fractions of crude obtainable by a simple distillation method or by commercial units. It also includes significant test factors for each fraction. As a result, it furnishes a relatively clear picture of crude oil composition, forecasting quality characteristics of the ultimate products obtainable from the five fractions in actual refining operations.

Accordingly, the Quality Index method appears to be a practical means for pricing crude oil and for simplifying market transactions.

Wants reprints

To The Editor: . . . would you kindly have 200 reprints prepared and sent to us at your earliest convenience. . . May I take this opportunity to commend you for the fine article ("New Mexico's First Cat Reformer—How It Works on a Mixed Feed," January, pp. 64-65). We are especially pleased to have ourselves represented in your nationally circulated magazine.

Walter Famariss, Jr.
President
Famariss Oil and Refining Co.
Hobbs, New Mexico.

Likes personal help

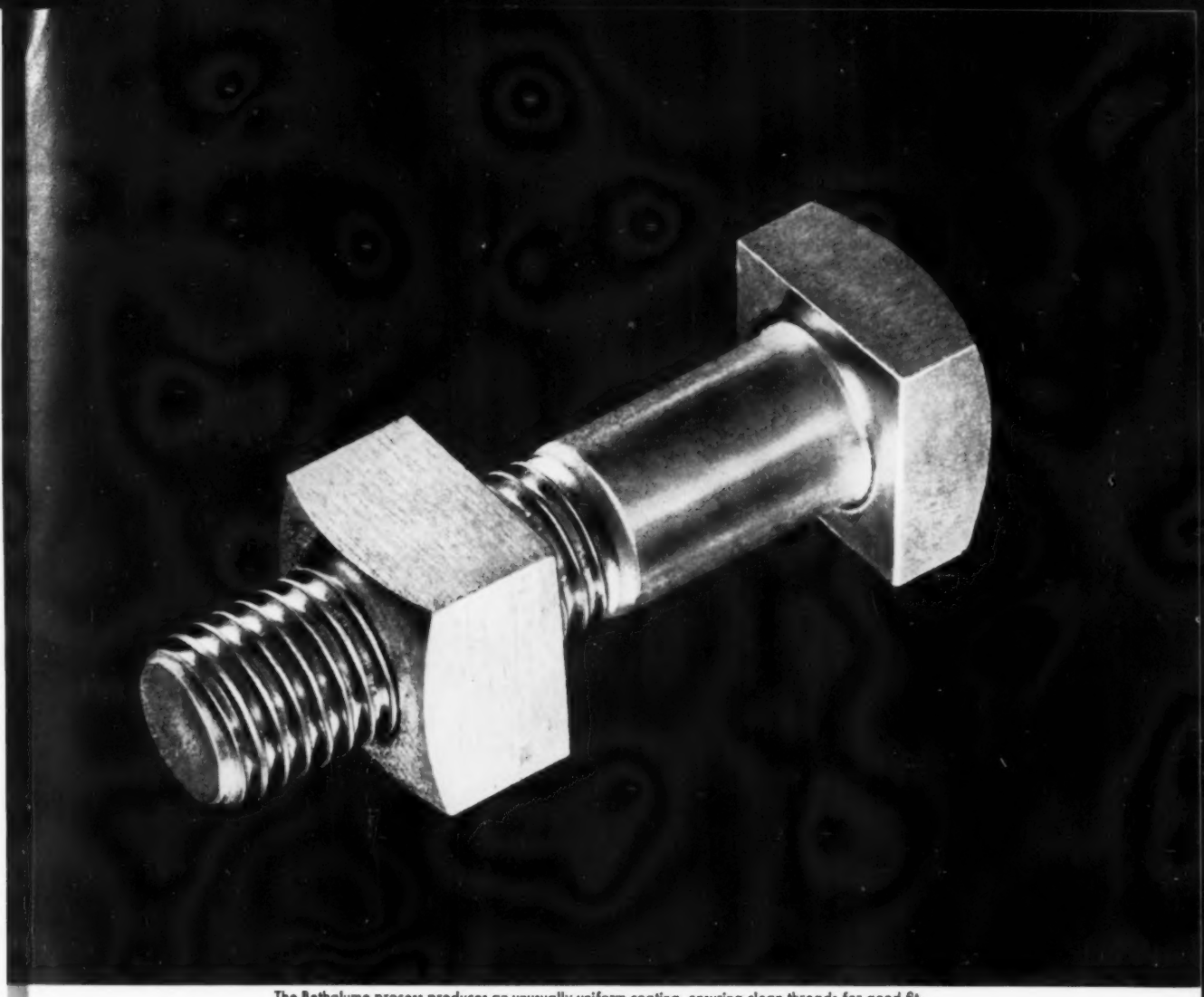
To The Editor: Self-development is of vital interest. We want the kind of articles your project will give us.

"How to Give a Technical Talk," by William Cullen Bryant, II, is particularly helpful (Feb., 1957, pp. 84-86). We'd like to get a reprint and would appreciate your sending us one or telling us where to get it.

Martin Lantau
Mgr., Engrg. & Maint.
Celanese Corp. of America
Bishop, Texas

● *Glad you liked it. Extra copy on way. Comments like these will make us eat our words yet (Feb., 1957, p. 7), and we like it.*

(To obtain more data on advertised products see page 280)



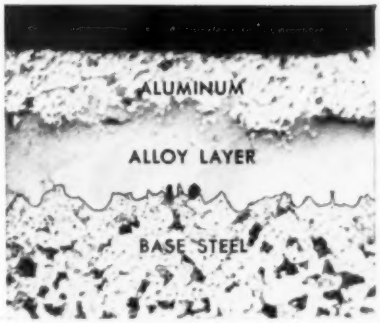
The Bethalume process produces an unusually uniform coating, ensuring clean threads for good fit.

Bethalume Coating Gives Fasteners Better Resistance to Corrosion

Fasteners used in corrosive atmospheres have a much longer service life, and require little or no maintenance, when protected by Bethlehem's Bethalume coating—a hot-dip coating of pure aluminum.

The Bethalume coating is effective in enabling fastener items to withstand the effects of corrosive atmospheres because it adds the permanence of aluminum to the strength of steel. The coating is tightly bonded to the base steel, and is uniform over the entire surface of the fastener. The coated threads are clean and smooth-fitting.

Why not look into the advantages of the Bethalume coating for your fasteners applications? A telephone call to the nearest Bethlehem sales office will bring one of our representatives to your desk promptly.



Photomicrograph of Bethalume coating. Pure aluminum is bonded to base steel by iron-aluminum alloy.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
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BETHLEHEM STEEL

BETHLEHEM STEEL

Announcing

Davi

(To obtain more data on advertised products see page 280)

antioxidants

Announcing Davison's antioxidants . . . Dav-Ad 101 . . . Dav-Ad 102!

Davison, long the leading catalyst supplier, offers these antioxidants to the refining industry . . . Dav-Ad 101 and Dav-Ad 102.

These antioxidants offer more advantages than other types for use in motor gasoline and aviation gasoline, as well as turbine oils, transformer oils, lubricating oils, jet fuels, synthetic lubricants, various plastics, rubber, industrial fats and oils, asphalt tile and waxes.

Davison maintains a staff of technical personnel complete with laboratory facilities available for consultation and assistance on inhibitor or treating problems.

Write for specifications, samples and prices.

Dav-Ad 101 available in 100 pound fiber drums . . . Dav-Ad 102 available in 55 gallon steel drums containing 400 pounds net or in tank car lots. Stocks are located at Baltimore, Md., Lake Charles, La. and Cincinnati, Ohio for your convenience.

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DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

SALES OFFICES: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.; San Francisco, Calif.; Tulsa, Okla.
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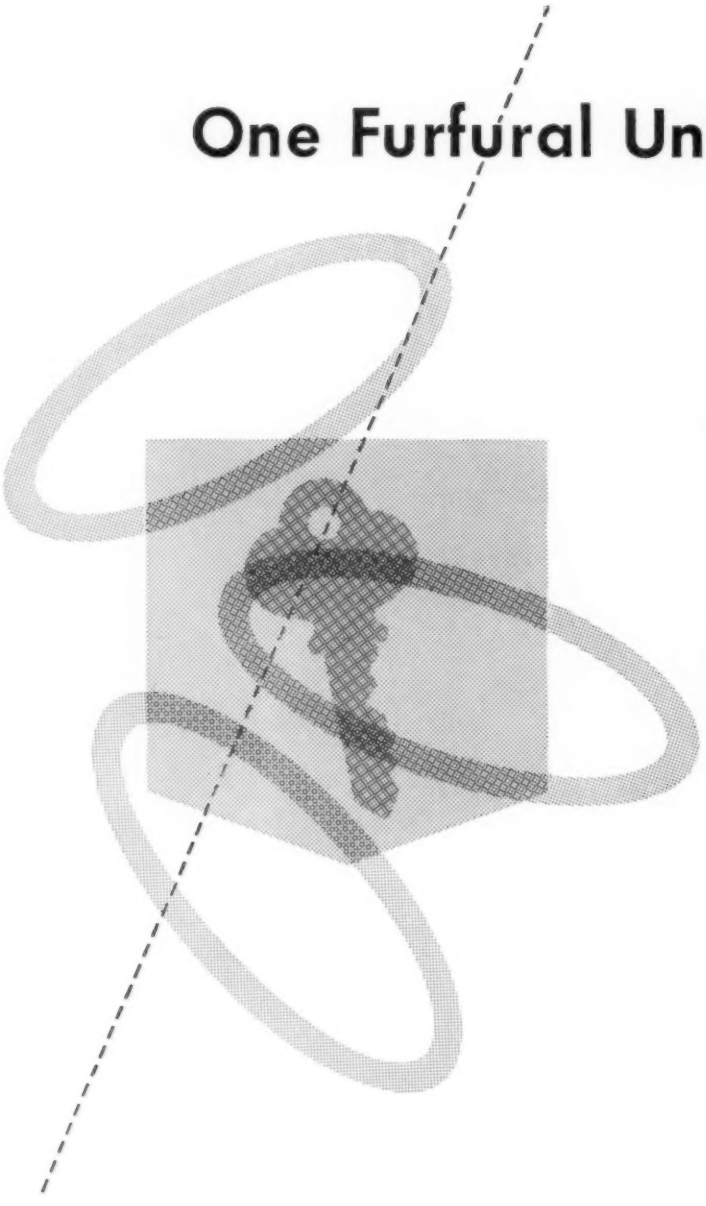
(To obtain more data on advertised products see page 280)

One Furfural Unit Refines All 3



- **LUBE OIL**
- **GAS OIL**
- **CYCLE STOCK**

Furfural has gained widespread recognition as a selective solvent in processing lube oil, and now is used to treat both virgin gas oil and cat cracker cycle oil. One of the outstanding features is that a furfural unit can be used alternately for refining lube, gas oil and cycle stock. Three companies are already using their furfural units for treating both lube oil and cycle stock; forty-two other users of furfural in the petroleum industry can do the same.

In refining middle distillates, furfural treatment improves product quality and increases cracker through-put. Furfural removes unstable materials that form coke, reduces sulfur content, and separates heavy metal complexes.

The same combination of basic properties and attractive economics which have made QO furfural so successful in refining lube oil applies with equal force to these newer applications. QO furfural offers sharp selectivity, ease of recovery, low cost, ready availability and freedom from excessive toxicity.

Write for our Bulletin 203-A
"Physical Data on QO Furfural."

The Quaker Oats Company
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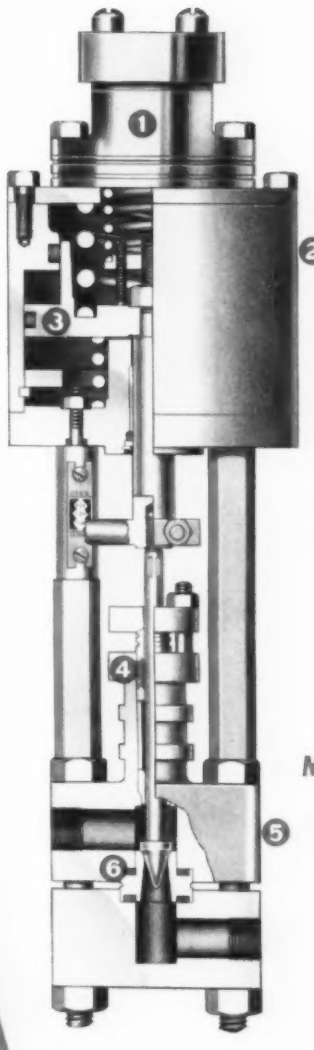
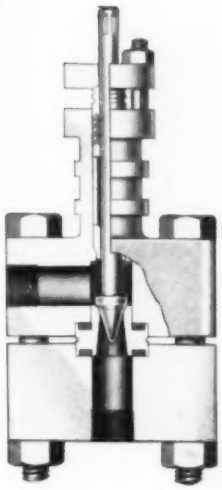
(To obtain more data on advertised products see page 280)

Split second action ...small flow control ...at 6,000 psi

New achievement by Annin in high pressure control and precise valve response for Research–Development–Process applications

Annin's new Model 9460, designed for working pressures to 6,000 psi, provides research, pilot plant and process control engineers with an extremely responsive small flow control valve suitable for low capacity systems. The operator will fully stroke in either direction in 0.75 seconds or less. New design features include: ❶ integral positioner, open-on-air-failure or close-on-air-failure action; ❷ Annin's 600 Series Domotor operator; ❸ differential area piston, eliminating need for loading regulator; ❹ universal stuffing box for −400°F to 750°F; ❺ offset globe or angle body design; ❻ valve plug stem and seat ring common to both globe and angle bodies. For reliable fluid control and flexibility of application Annin offers the *best source* for solving any small flow control problem.





Model 9461 *angle body*

Angle bodies are available with body sections rotatable in 90° increments for piping convenience.

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Complete information and specifications are contained in Bulletin No. 9400. Write for your copy today.

ANNIN *Control* **VALVES**

THE ANNIN COMPANY
DIVISION OF THE ANNIN CORPORATION
6570 Telegraph Road, Los Angeles 22, California

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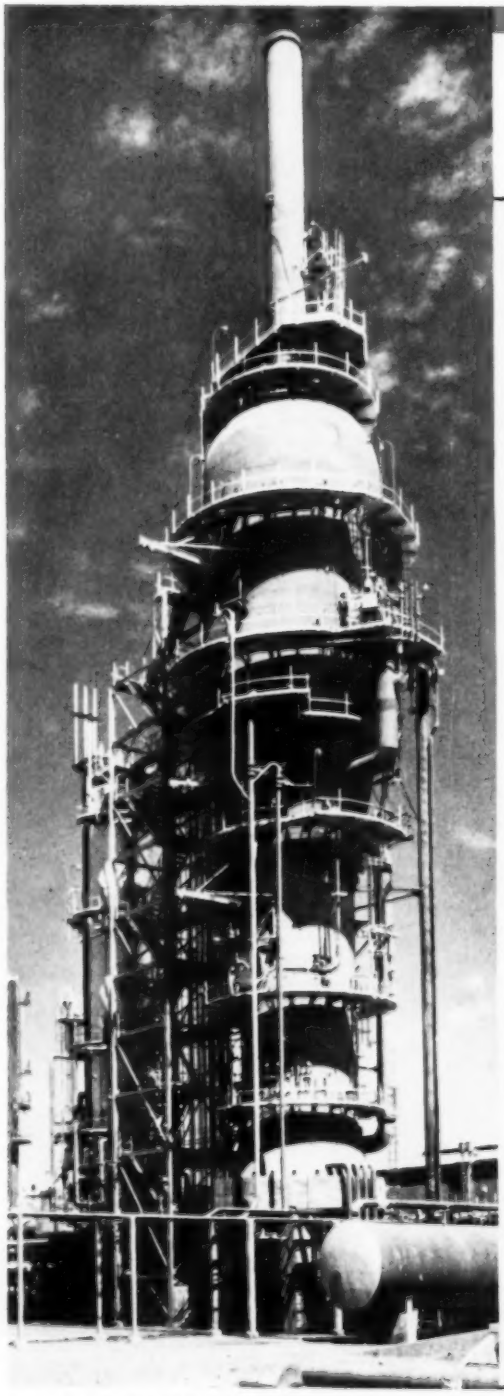
Orthoflow®



ORTHOFLOW FLUID CATALYTIC CRACKING UNITS BY THE M. W. KELLOGG COMPANY

DATE ON STREAM	LOCATION	DESIGN CAPACITY Total Throughput, BPD
1951	Edmonton, Alberta	3,500
1951	Ponca City, Okla.	10,939
1952	Sarnia, Ontario	14,027
1953	Gelsenkirchen, Germany*	5,000
1953	Toledo, Ohio	17,705
1954	Smiths Bluff, Texas	26,625
1954	Clarkson, Ontario	17,415
1954	Philadelphia, Pa.	45,000
1955	Amarillo, Texas	9,706
1955	Kwinana, Australia	12,500
1955	St. Boniface, Manitoba	8,374
1955	Enid, Okla.	13,500
1956	Delaware City, Del.*	101,800
1956	Yorktown, Va.	30,618
1956	Puerto La Cruz, Venezuela	14,290
Future	Mataripe, Brazil	20,493

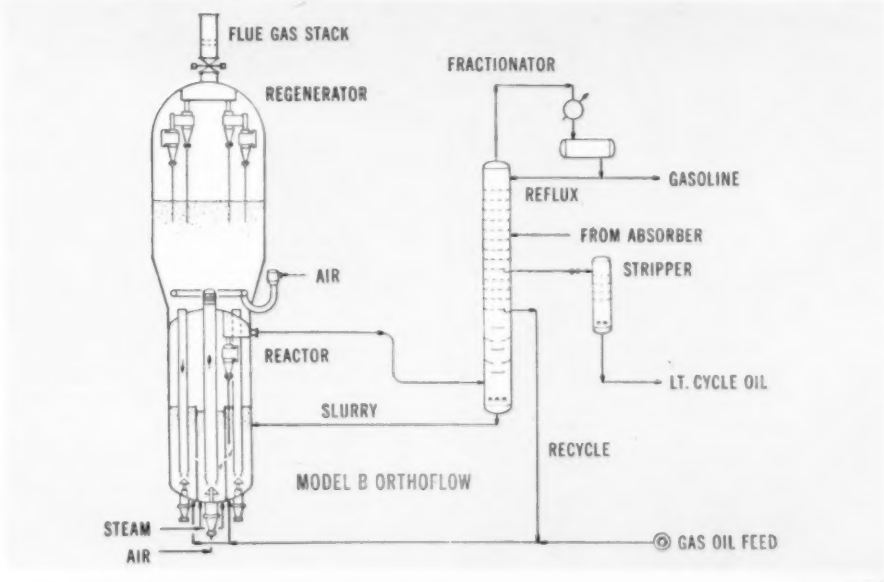
® *Trademark of The M. W. Kellogg Company*

**Process and Engineering only*

is on the go

Low initial investment, low direct operating expense, and low maintenance costs have brought world-wide recognition in a few short years to the Orthoflow Fluid Catalytic Cracking Unit—a development of Kellogg's many years' experience in engineering and erecting fluid cat crackers of other types.

For refiners contemplating expansion with the earliest possible on-stream date, Kellogg engineers will be glad to interpret the economics and efficiency of the Orthoflow vertical design in terms of individual refinery conditions and requirements.



Refinery Process Division

The M. W. Kellogg Company

711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

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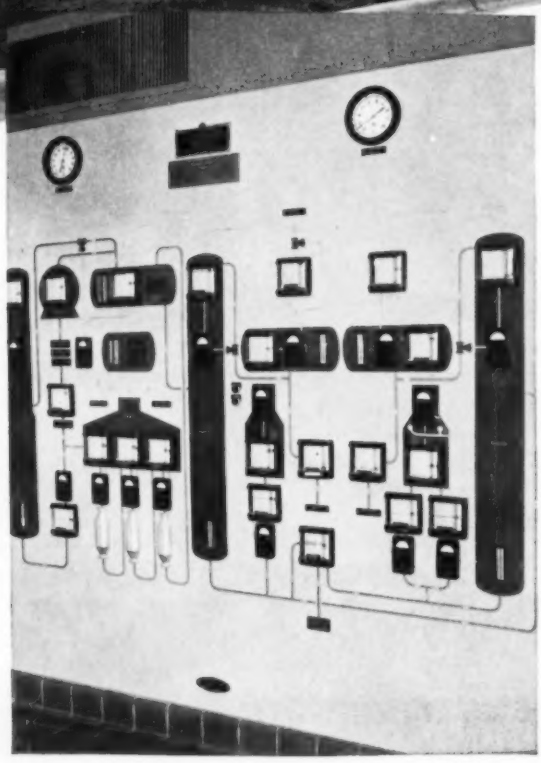
THIS REFINERY GOES ELECTRONIC...



Pontiac Refining Company in Corpus Christi installed a new reformer in 1956 to produce 100+ octane gasoline. Because distances from the control house to the process range up to 800 feet and some of the variables were difficult to control, 'American-Microsen' Electronic Instruments were selected.

The control house contains 'American-Microsen' Controllers for pressures, flows, levels, and temperatures of the process materials at vital stages of the platforming process. Despite the long distances and fast-acting variables, the instruments provide control well within the tolerances required to produce high-octane motor fuel.

Such results are possible because the 'American-Microsen' System is completely electronic, with dc transmission signal that is insensitive to distances as great as 30 miles. The high speed and sensitivity of the electronic design improve the control of all process variables.

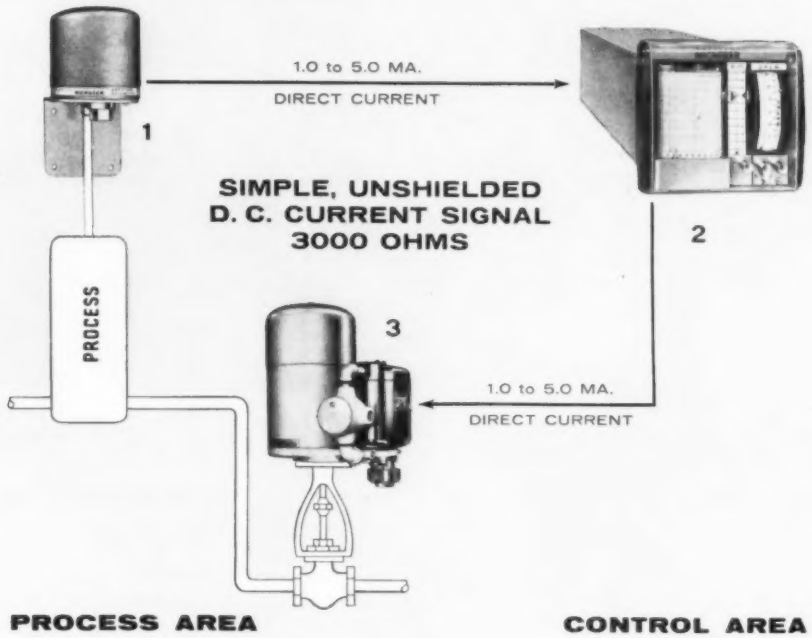
Now in operation over a year at Pontiac Refinery, the 'American-Microsen' System continues to give complete satisfaction — continues to help turn out high grade motor fuel. It is typical of many successful installations, and more and more companies are specifying the system for new plants as well as in modernizing existing processes.

Even though the electronics approach in process control is revolutionary, the 'American-Microsen' System of today incorporates the latest design techniques. Transistors are used for the ultimate in reliability and service life, and printed circuits and miniaturized components provide space-saving simplicity. The complete process control system now uses only three units.

(To obtain more data on advertised products see page 280)

the modern way to control process variables

'AMERICAN-MICROSEN' ELECTRONIC PROCESS CONTROL SYSTEM HELPS PRODUCE HIGH-OCTANE MOTOR FUEL



1. **TRANSMITTER.** 'American-Microsen' transmitters are used for measuring pressure, temperature, differential pressure, liquid level, flow, and other process variables. The "Microsen" balance creates a stable dc signal for long distance transmission. Transmitters have a minimum of bearing pivots or linkages—assuring sensitivity and repeatability of measurement.

2. **CONTROLLER.** A single unit combines all functions of measuring and recording or indicating the input signal; producing the control signal; and allowing manual-automatic process operation. Separate plug-in chassis provides the following functions: A. Records or indicates process variable. Strip or card chart recorder chassis available. B. Produces proportional, reset and rate control actions to regulate the variable. All control settings are calibrated. C. Permits switching to manual operation during start-up or emergency conditions, with true "bumpless" transfer from manual to automatic control.

3. **ELECTRO-HYDRAULIC CONTROL VALVE OPERATOR.** A power unit with position feedback that operates slip-stem control valves. No compressed air is needed. Mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal percentage plugs, including valves of 4" stroke, and force available up to 3,250 lbs.

Where required, the 'American-Microsen' Electro-Pneumatic Valve Positioner or the Electro-Pneumatic Transducer can be supplied.

In automating your processes for higher product quality and greater operating economy, you want the better control and simplified servicing provided by the 'American-Microsen' Electronic Process Control System. We invite you to meet with one of our sales engineers to determine the best equipment for your service. Write for literature.

MANNING, MAXWELL & MOORE, INC.

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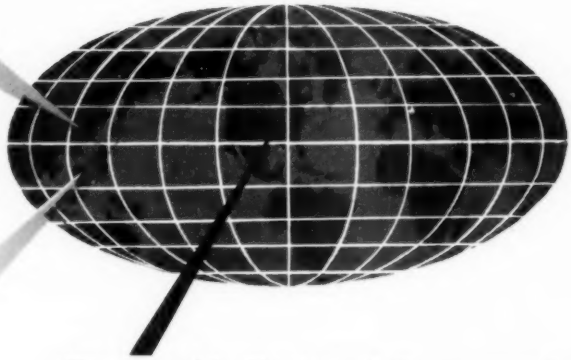
MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

UREA

...the commercially proven CHEMICO PROCESS

A view of the 90 tons per day Urea Plant at Niigata designed by Chemico for Nippon Gas Chemical Industries Ltd.

A part of the 120 tons per day Urea Plant designed by Chemico for Sumitomo Chemical Company Ltd. at Niihama.



NOW...200 T/D
under contract in North America

The success of the Chemico synthetic urea process is reflected in the company's record in Japan. The 40 tons per day plant built for Sumitomo Chemical Company at Niihama in 1952 has been expanded twice to 120 tons per day operation. On the basis of this record, Chemico was awarded a contract by Nippon Gas Chemical Industries for a 90 tons per day plant at Niigata. This plant started on stream in the spring of this year. Now . . . Chemico has been awarded the contract for a 200 tons per day Urea Plant in North America, utilizing the Chemico process. Production experience at the Sumitomo plant has shown the following advantages of the Chemico urea process:

- High conversion of the carbamate to urea per pass.
- Simple recovery of the excess ammonia in liquid form without additional compression.
- Efficient recovery of the ammonia from the unconverted ammonium carbamate for full recycle to obtain overall high ammonia yield.
- Produces spherical free-flowing granules which require no coating agents.
- The Chemico process can be used for the production of urea in fertilizer and industrial grades.

For more detailed information on the commercially proven Chemico process, write, wire or call . . .

CHEMICO

CHEMICAL CONSTRUCTION CORPORATION
A SUBSIDIARY OF ELECTRIC BOND AND SHARE COMPANY

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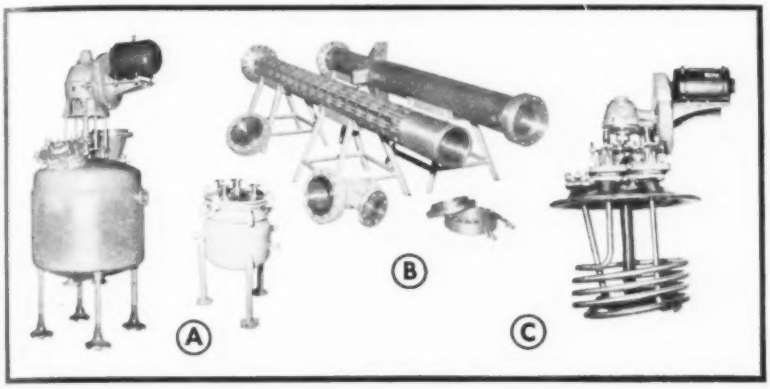
Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.



A. Pfaudler titanium reaction kettles for high-temperature processing.
B. Pfaudler packed floating head titanium heat exchanger.
C. Pfaudler titanium loop coil for use in titanium reactor.

When should you use titanium process equipment?

Titanium, a relatively new material of construction, shows great promise in reducing corrosion costs under severe chemical conditions.

As corrosioneers, Pfaudler has studied its characteristics, developed welding techniques, designed and built quite a range of titanium process equipment. Some are shown above and others are being fabricated now.

Because production costs of titanium have been greatly decreased, titanium should now be considered as a material of construction wherever it is economically feasible to do so. It has superior resistance to nitric acid solutions at high temperatures, chlorinated organics and inorganic chloride solutions, and shows excellent resistance to mixtures of sulphuric and nitric acids and also to aqua regia.

There are also other materials which provide excellent chemical resistance, among which is Pfaudler glassed steel. Each case should be considered on its own merits.

Our main point is this: When you are up against any kind of a corrosion problem, Pfaudler is ready and anxious to give you the benefit of its 73 years of experience in designing and fabricating equipment that will do the best job at *the lowest over-all service cost*. If titanium is indicated, you can rely on Pfaudler know-how to do just that. Your inquiries are welcomed.

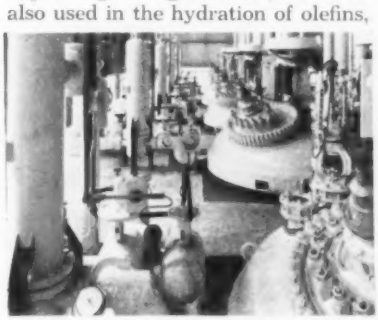
Copper and copper alloy equipment . . . For services involving acid solutions of low oxidizing capacity, copper and copper alloys may be the best answer to your problem. Pfaudler's long experience in building copper vessels and heat exchangers assures you of top-quality engineering and workmanship. You will also find Pfaudler prices competitive. Let us quote on your requirements for equipment of this type.

Glassed steel for the petroleum industry

The petroleum industry, like chemical processing, finds in glassed steel equipment a material of construction which is proving most economical in the battle against corrosion.

Great improvement in the resistivity of Pfaudler glass and its application to many different types of open hearth steel designs, are mainly responsible for this trend. Pfaudler glass, now resistant to all acids (except hydrofluoric) and to alkaline solutions to pH 12 at 212° F., provides about as much flexibility as you can find in any one material of construction.

Used in the form of reactors, columns, settlers, mixers, storage tanks, pipe, fittings and valves, Pfaudler equipment is giving excellent service for reactions involving hydrochloric acid, chlorinated solvents, pesticides, vapor degreasing solvents, etc. It is also used in the hydration of olefins,



to prevent corrosion by sulphuric acid, in certain phases of producing cumene-derived phenol and by-product acetone in polyester resins and synthetic fibres.

Installations of Pfaudler glassed steel polymerizers are so numerous that standardized designs have been developed. Glassed steel can be cleaned quickly after each run: a build-up of product within the vessel is easily prevented.

In petroleum refining operations, corrosion during crude distillation has been minimized. Glass helps to prevent passage of hydrogen to the steel surface, eliminating atomic hydrogen attack. There are other applications too numerous to include here. May we send you more information?

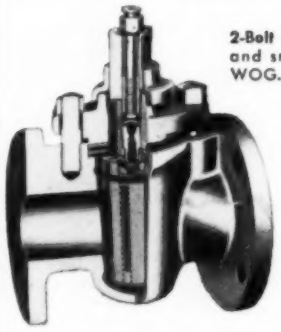
 (To obtain more data on advertised products see page 280)

Cut flow control costs... standardize on...

THE WORLD'S MOST COMPLETE

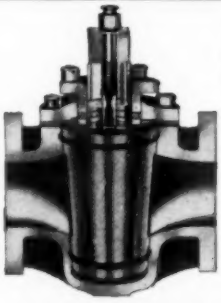
LUBRICANTS and

VALVES



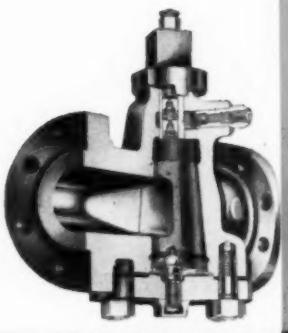
2-Bolt Cover Type Valve in 4" and smaller sizes for 175-lb WOG. *Semi-Steel*

Screwed Gland Type Valve in 4" and smaller sizes for 200, 400 and 500-lb WOG. *Semi-Steel*



Bolted Gland Type Valve in 4" to 36" for 200 through 800-lb WOG Semi-Steel and ASA 150-lb and 300-lb Carbon Steel.

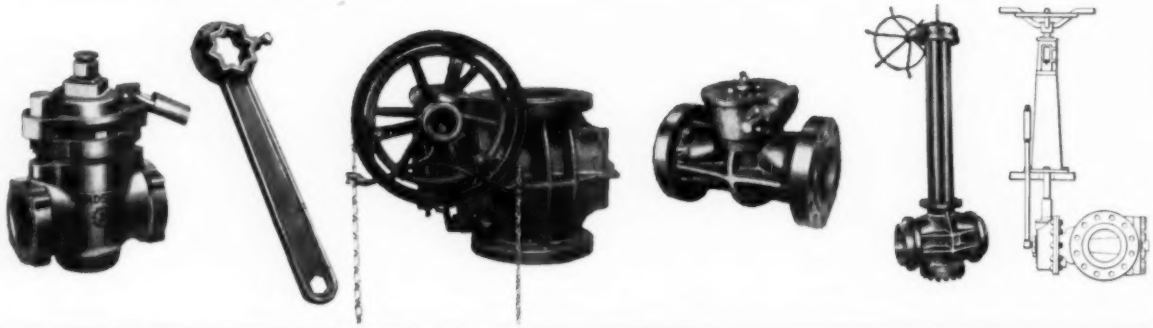
Hypreseal Valve—Bolted Bottom Cover Type. ½" to 30 by 34" for ASA 150-lb through 1500-lb Carbon Steel (with rectangular opening). API 2000-lb and 3000-lb WOG Alloy Steel Rectangular Opening. API 2000 and 3000-lb WOG Alloy Steel (with round opening).



LUBRICANTS

PROPER VALVE LUBRICATION means longer valve life and better performance at lower cost. Rockwell is the world's oldest and most experienced manufacturer of lubricated plug valve lubricants. To assure perfect performance, a *complete line* of lubricants has been developed and field proved. For convenience, they are available in stick, tube and bulk forms. The Rockwell High Pressure Booster Type Hand Gun and Rockwell High Pressure Booster Type Bucket Gun make the lubrication of even a great number of valves a job that takes only minutes.

ACCESSORIES

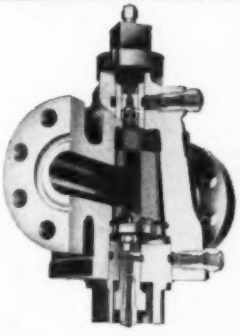


GREATER DESIGN AND INSTALLATION FREEDOM are the "extras" you get when you specify Rockwell-Nordstrom valves and accessories. No matter what your operating requirements or problems, you can select from a *complete* line of valve accessories that assure easier, safer, more efficient operation.

While only a few of the valve accessories are shown above, you can learn about the complete selection by talking with your Rockwell-Nordstrom sales engineer or writing directly to: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pennsylvania.

LINE OF LUBRICATED PLUG VALVES,

ACCESSORIES



Hypreseal Valve—Screwed Bottom Cover Type. ½" to 8" for 7500-lb WOG Alloy Steel (rectangular opening). ASA 2500-lb Carbon Steel (rectangular opening). API 5000-lb and 10,000-lb WOG (rectangular opening) and API 5000-lb and 10,000-lb WOG (round opening).

Multiport Valve Type. Available in Gland type and Hypreseal type in WOG pressures to 400 lb and ASA pressures to 1500-lb. Sizes from ½" to 24".

ALL THESE ADVANTAGES
In *Every* Rockwell-Nordstrom Valve.

LEAKPROOF: Lubricant sealing is a *double* seal against leakage.

LONG-LIFE: Lubricant prevents metal-to-metal wearing friction.

LOW-COST: Lubrication is preventive maintenance.

DEPENDABLE: Hydraulic lubricant action jacks plug for instant operation.

QUARTER-TURN OPERATION: 90° turn for *full* positive shut-off.

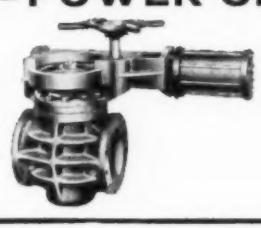
SMOOTH PASSAGE: Straight-through flow without crevices . . . minimum pressure drop.

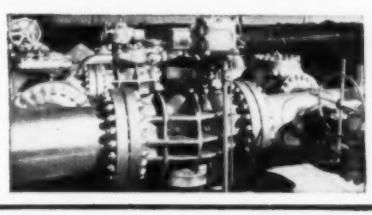
UNEXPOSED SEATS: Corrosion and erosion eliminated in vital seat areas.

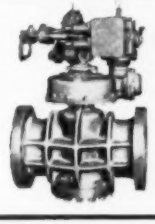
ADJUST, LUBRICATE UNDER PRESSURE: Never down time for routine servicing.

No other valve—at any price—can offer the performance and longer life at lower cost of Rockwell-Nordstrom valves.

POWER OPERATORS



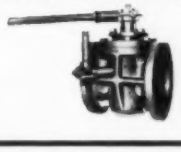


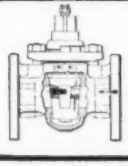


AUTOMATIC VALVE OPERATION is more dependable and economical when you specify Rockwell-Nordstrom valves. They are far superior to ordinary valves for power operation because *lubrication* reduces operating torque—smaller, less costly actuators can be used. And since there are no forced, wedged seats to be set, the actuator has only to move the lubricated plug through 90°.

Typical electric, pneumatic and cylinder operators shown above represent only three of the more than fourteen power operation arrangements available.

VALVES WITH SPECIAL FEATURES





NO MATTER WHAT YOUR NEEDS, there is a Rockwell-Nordstrom valve that will do the job better, longer and at lower cost. A few of the Rockwell-Nordstrom valves with special features are shown above.

Special metal valves are available in stainless-steel, bronze and other corrosion resisting alloys for even the toughest services. Valves with *hard faced plugs and bodies* combine the economy of semi-steel with hard facing for utmost corrosion and wear resistance. *Steam jacketed valves* for precise product temperature control. *By-pass relief valves* prevent pressure build-up that imposes dangerous stress on ordinary valves and fittings. *Gas safety control (Factory Mutual) valves* for positive control against explosion in multi-burner gas-fired furnaces, ovens and driers.

* * * *

Rockwell-Nordstrom valves and accessories are available at leading oil field and industrial distributors everywhere. For full information write: Rockwell Manufacturing Company, 400 N. Lexington Avenue, Pittsburgh 8, Pa. Canadian Valve Licensee: Peacock Brothers Limited.

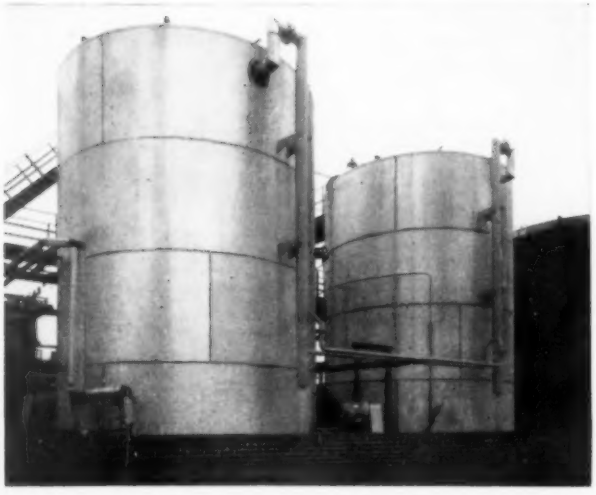
ROCKWELL-Nordstrom VALVES

Lubricant Sealed For Positive Shut-off

Reflux condensers for soap neutralization, made from 1/8"-thick type 304 Stainless.

Not a Single Stainless Steel failure

in equipment for handling finished detergents



Synthetic detergent tanks (Stainless) have been in service for four years and are still as good as new. Previous coated tanks lasted 18-24 months.

The Atlantic Refining Company's Philadelphia refinery produces detergents as one of the derivatives.

Product contamination was the big problem. They tried sprayed-on plastic and phenolic coatings, but they all failed. Since they installed Stainless Steel, there has not been a single failure in the finished product handling equipment. There has been no corrosion problem. No contamination.

Nothing can equal Stainless Steel in its combination of properties: corrosion resistance, surface smoothness and denseness, strength and hardness, easy fabrication. Think of Stainless when you plan. Think of *USS* Stainless when you buy.

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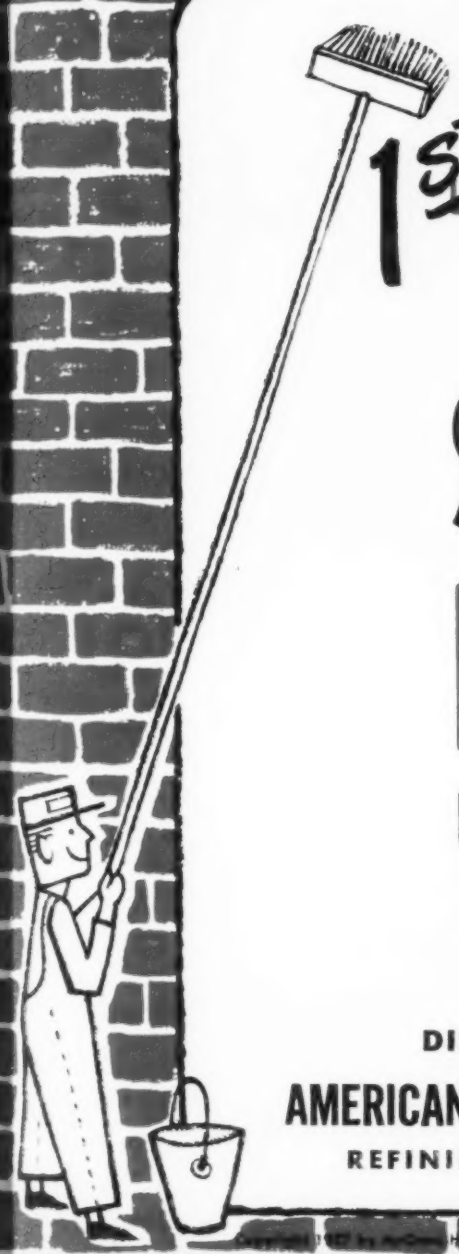
UNITED STATES STEEL

Petroleum Processing



1st TRADE SHOW IN PRINT 1957

DISTRIBUTED AT THE

AMERICAN PETROLEUM INSTITUTE

REFINING DIVISION MEETING

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FIRST ANNUAL

Petroleum Processing

TRADE SHOW IN PRINT

1957

As an addition to Petroleum Processing's special services in connection with the Annual Refining Division Meeting of the American Petroleum Institute we herewith submit the 1st Annual TRADE SHOW IN PRINT. In this pioneering effort sixty exhibitors (advertisers) have gone along with us. We expect the results to justify their confidence in the idea and convince them they should be back with us next year with more space. We hope they will be joined by many others next year. The larger the number of exhibitors (advertisers) the more useful it will be to those who attend the convention whether in person or in print.

There is no industry trade show in the petroleum processing industry. None have ever been allowed in conjunction with the American Petroleum Institute meetings. We hope this TRADE SHOW IN PRINT will help fill the need for a Trade Show in our industry.

Please turn to the back cover and see how you can get more information about the products described. The special reader service cards are designed to be used with a special code which identifies the individual products advertised. If 12 different products or items of literature are described in one advertisement this system allows you to identify the exact product or literature you are interested in. Please tear out the last page with the code numbers and take it with you as your guide to the TRADE SHOW IN PRINT.

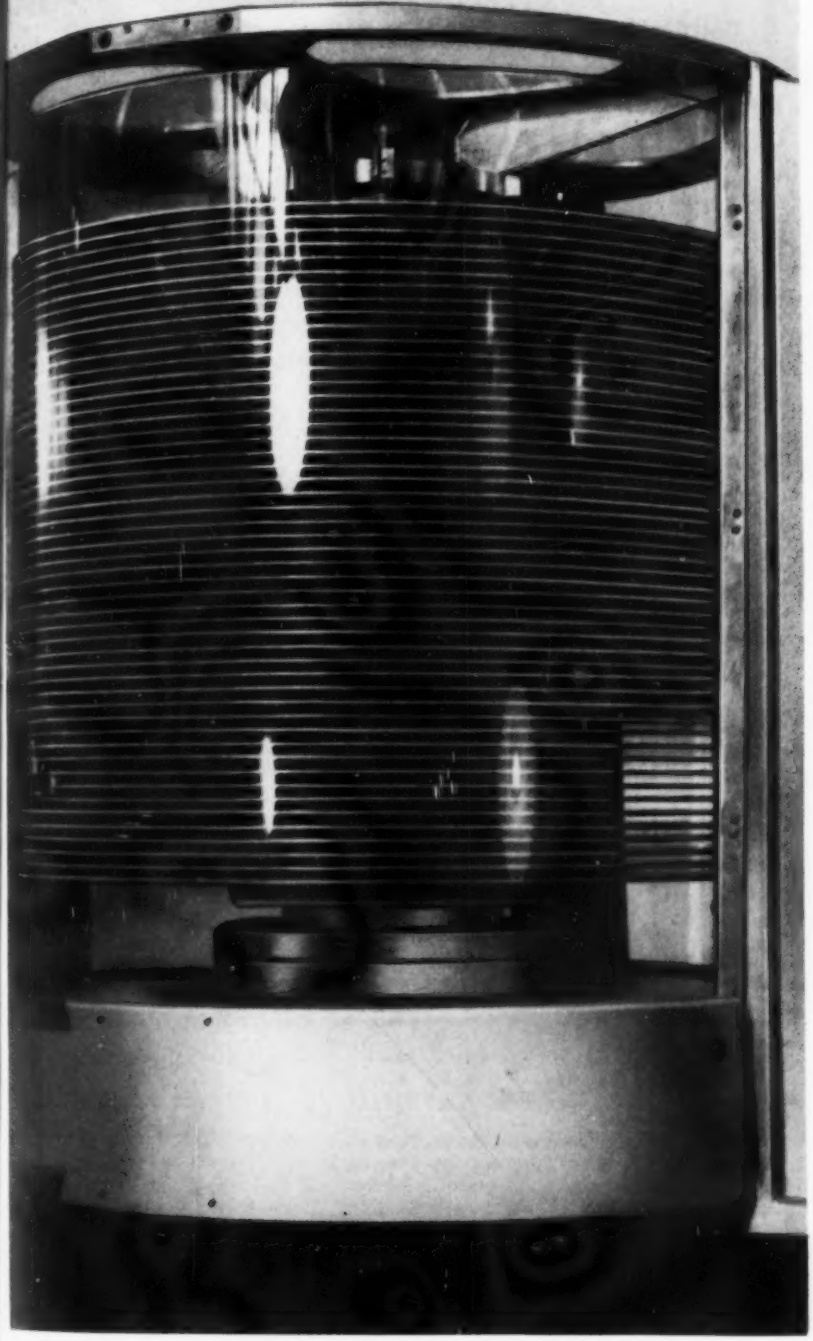
The center section of the TRADE SHOW IN PRINT contains the most complete Refinery Directory yet published. It also contains a Glossary of refining and petrochemical processes with 74 process flow diagrams, and an up-to-date Directory of Engineering and Construction Firms who license, design and build these processes. You will want to keep this section for future reference. Further explanation of the Directory will be found on page 79.

NOW—"SINGLE STEP" PROCESSING FOR PETROLEUM ENGINEERING & ACCOUNTING

IBM

RAMAC

Random Access Method of Accounting and Control



With these whirling magnetic disks, RAMAC gives you "memory in the millions". . . an unprecedented electronic memory in which millions of petroleum facts and figures can be stored economically, at random, and yet be immediately accessible!

For RAMAC®—a random access method of accounting and control—has the first electronic memory which can file or find any data instantly, without searching or sorting. And with RAMAC, the long-sought goal of "single step" data processing is achieved.

RAMAC provides extreme flexibility to store complete programs for simulation routines. It permits the storage of multiple programs with instant input, computation and call out!

Whether for engineering computations or accounting, this new Random Access Method of Accounting and Control delivers the ultimate in data processing speed, flexibility and accuracy. Get the full RAMAC story from your local IBM representative or write: Petroleum Department A57, International Business Machines Corporation, 590 Madison Avenue, New York 22, N. Y.

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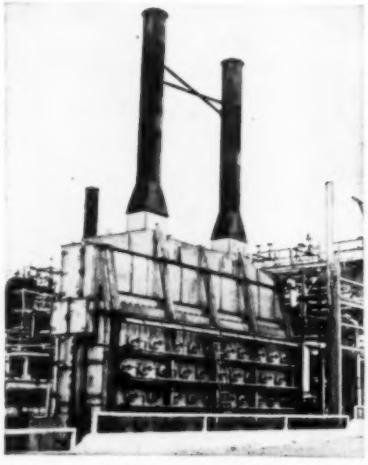
Nikkatsu International Bldg.
1-1 Yurakucho Chiyoda-Ku

Main Office & Plant: Dresher, Pa. Phone: Mitchell 6-6600

Heat Processing Equipment for the Chemical and Petroleum Industries



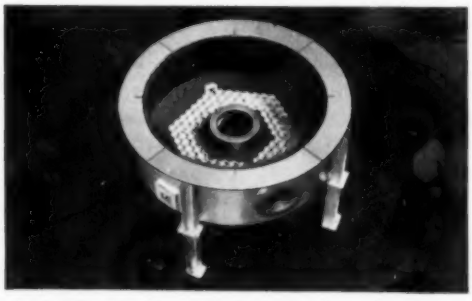
20 million Btu Gradiation heater used in high vacuum refining.

SELAS GRADIATION® HEATERS OFFER THESE ADVANTAGES:

- Zones of controllable heat input
- Complete combustion with little or no excess air
- Uniform application of heat
- Shop assembly or field-erection, as desired.

Processing Features: Safe use of high average heat transfer rates; positive control of temperature gradient; full heat pick-up with lower pressure drop and residence time; minimized coil coking; constant tube-wall temperature; improved fuel economy.

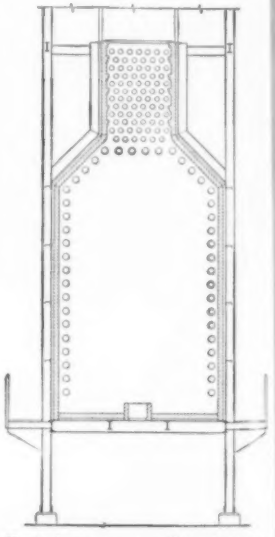
Construction Features: Multiple coil installations; rapid response to process changes; extended coil life through elimination of external oxidation. Bulletin S1043.



Typical Duradiant hearth-fired furnace prior to insertion of kettle or reactor. Burner assembly provides for bottom kettle discharge.

SELAS LOW-COST HEATERS FOR CONTINUOUS NON-CRITICAL PROCESSING

Selas designs and constructs economical tube-still heaters for processing materials below their decomposition temperatures. Illustrated is one of several possible arrangements.



Typical arrangement, Selas low-cost tube still

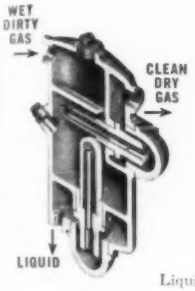
SELAS DURADIANT® FURNACES FOR BATCH PROCESSING

• For batch heating chemicals, oils, resins, varnishes, inks—Selas Duradiant enclosed or open settings offer these advantages: fast, radiant gas heating; rapid burner response and turndown ratios of 15:1 or more; uniformity of heat application; adherence to critical programming requirements. Selas furnaces permit time-temperature cycle control within several °F, batch after batch. Steel-encased, they are shipped with all refractory in place for simple installation. "Packaged" equipment includes shop-assembled piping and complete, automatic control instrumentation. Bulletin SC1015.

SELAS CORPORATION OF AMERICA

Fluid Processing Equipment for Chemical, Petroleum and Allied Industries

LIQUID-GAS SEPARATION

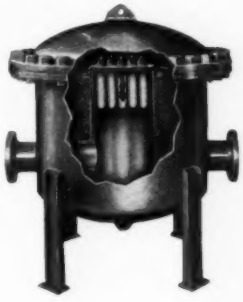


Liqui-Jector

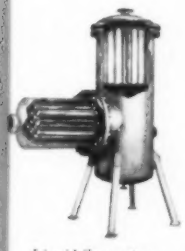
Selas Liqui-Jectors® utilize basic principles of capillary physics and surface chemistry. Protect air, gas and steam systems and pneumatically-operated instruments and mechanisms from effects of entrained water, oil, water-oil emulsions and dirt. Easily installed, no moving parts, minimum maintenance. Standard models available for capacities up to 7000 scfm at pressures up to 200 psig. Units custom-built for larger volumes, higher pressures, special conditions. Bulletin S1052.

HYDROCARBON VAPOR ADSORPTION

Selas Vape-Sorbers® continuously remove hydrocarbon vapors, liquid hydrocarbons, water hydrocarbon emulsions and dirt from compressed air and process gases (nitrogen, hydrogen, carbon dioxide, inert gases). Capacities up to 2500 acfm at pressures up to 5000 psig. Bulletin SC1047.

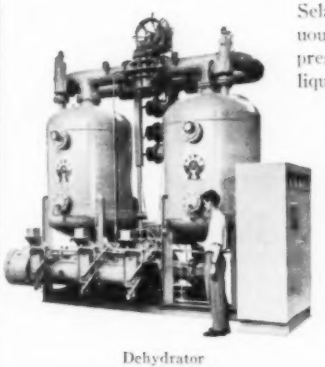

Vape-Sorber

LIQUID-LIQUID SEPARATION


Liquid Separator

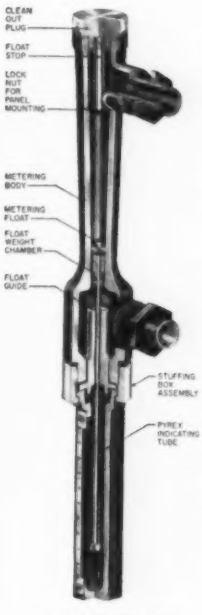
Selas Liquid Separators continuously separate emulsions in steam distillations, solvent extractions, organic reactions. For dewatering of solvents and hydrocarbons, recovery of organic liquids. Capacities of single units range from 10 to 6000 gph. Bulletin SC1044.

LIQUID AND GAS DRYING


Dehydrator

Selas Dehydrators provide continuous, automatic drying of compressed air, process gases and liquids. Gases include carbon dioxide, carbon monoxide, hydrocarbons, hydrogen, inert gases, nitrogen, oxygen. Liquids include propane, butane, kerosene, benzol, toluene, xylene. Available for manual, semi-automatic and fully automatic operation in capacities from 10 to 15,000 scfm for gases; up to 200 gpm for liquids. Bulletin SC1013.

FLOW MEASURING EQUIPMENT



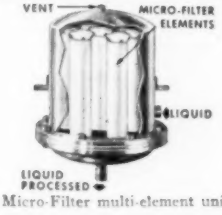
Series F Flo-Scope

Selas Flo-Scopes® accurately measure flow rate of air and gases.

- Quick, easy panel or "in-line" mounting.
- Full size range, capacities to 75,000 cfh air.
- Heavy-walled Pyrex glass extension tube.
- Rugged stuffing box design prevents leakage.
- All scales in full view, easy to read.
- Colored indicating target increases visibility.
- Convenient top clean-out plug simplifies cleaning. Bulletin SC1022.

MICRO-FILTRATION

Selas micro-porous porcelain filters are used for clarification, polishing, cold sterilization of pharmaceuticals, biologicals, fine chemicals and other continuous operations where physically pure liquids are required. Selas Micro-Filters contain inert, micro-porous porcelain filter elements in single and multi-element units, and are designed and built for aseptic or corrosive conditions. Bulletin SC1051.



Micro-Filter multi-element unit

PATENT CHEMICALS, INCORPORATED

MANUFACTURERS OF DYES AND CHEMICALS FOR THE PETROLEUM INDUSTRY

ANNOUNCES

a bright new

RED

by the Pioneers in Petroleum Dyes

PETROL RED AB4 DRY DYE

PETROL AB4 25% CONCENTRATE

PETROL RED AB CONCENTRATE

Developed for cleaner, easier gasoline coloring. Eliminates pre-dissolving, dusting, operator exposure. Less skill and equipment required. Introduced directly into the finished gasoline. A valuable aid for tank car and tank truck coloring.

Petrol Red AB Concentrate is a 25% dry dye content by weight, pourable at normal temperatures – produces a bright clear standard red shade in gasoline—excellent for masking orange colored gasolines.

SPECIALLY DEVELOPED FOR GASOLINE MARKING

DESCRIPTION
Petrol Red AB Concentrate

S.G. @ 75° F.	.928
Lbs. concentrate per gallon	7.7
Lbs. concentrate per quart	1.9
Lbs. concentrate per pint	.96

DRY DYE CONTENT

Lbs. per gallon of concentrate	1.9
Grams per gallon of concentrate	877.3
Grams per quart of concentrate	219.3
Grams per pint of concentrate	109.6
Grams per ounce of concentrate	6.8

Being thixotropic, the concentrate may congeal at low temperatures, or upon standing for long periods, becoming fluid when agitated.

Petrol Red AB Concentrate is compatible with other dyes and may be used for blending purposes.

Meets MIL-F-5572 Specifications.

DESCRIPTION
PETROL RED AB4

SOLUBILITY: 1250 grams to 1330 grams per 100 gals. gasoline.

STRENGTH: 97.5-102.5% against type.

SHADE: Bright clear red shade designed to overcome color of orange colored lead fluids.

BENZOL INSOLUBLE CONTENT: Less than 3%.

MOISTURE CONTENT: Less than 2%.

PROPERTIES: High melting point • Non-caking • Designed to overcome lumping in storage, shipping, high temperature and warehousing conditions • Low bulking material.

USES: Excellent for eductor systems, coloring of premium gasolines and general petroleum use.

STANDARD PACKING: 100 pound lever packed fibre containers.

Meets MIL-F-5572 SPECIFICATIONS.

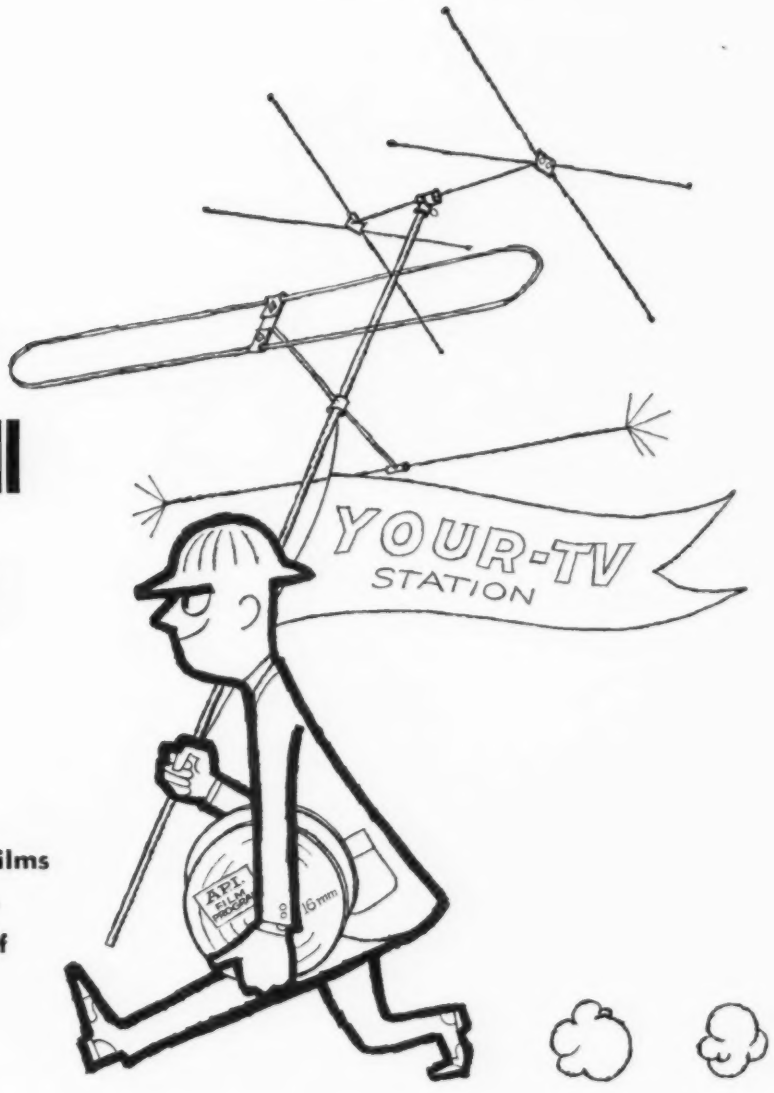
PATENT CHEMICALS INC.

Manufacturing Division: 335 McLean Blvd., Paterson 4, New Jersey

PATENT FUELS & COLOR CORP.

Marketing Division: 2410 Carew Tower, Cincinnati 2, Ohio

Now you can help tell oil's story on TV!



Bring "PROGRESS PARADE" films to *your* local TV station— build prestige for yourself and your industry!

The Oil Information Committee is producing a series of special TV programs about the oil industry called "PROGRESS PARADE." Each program takes the viewer "behind the scenes" to show him this vital industry is working in his best interests. All phases of the industry are covered—and because the programs are informational in nature, stations are glad to telecast them in the public interest—without commercials.

"PROGRESS PARADE" offers you an excellent opportunity to participate in your industry's public relations program and to tell your neighbors how petroleum helps make their everyday lives more enjoyable, more worthwhile.

The Program Manager of your local TV station is constantly looking for new program features and will be happy to receive these specially prepared 13½-minute films. Four different TV films are issued every year.

How to get "PROGRESS PARADE" television films

First check if the TV station in your community has the latest "PROGRESS PARADE" film. If not, just get in touch with your local Oil Information Committee. They will provide you with the most current "PROGRESS PARADE"—and any additional information you'll need.

Don't miss this opportunity to tell *your* story—the oil story—on television. You'll be helping yourself, your company and your industry all at the same time!

American Petroleum Institute
50 W. 50th St., New York 20, N. Y.

I would like to have the "PROGRESS PARADE" films televised in my community. Please send me the address of my nearest Oil Information Committee District Office.

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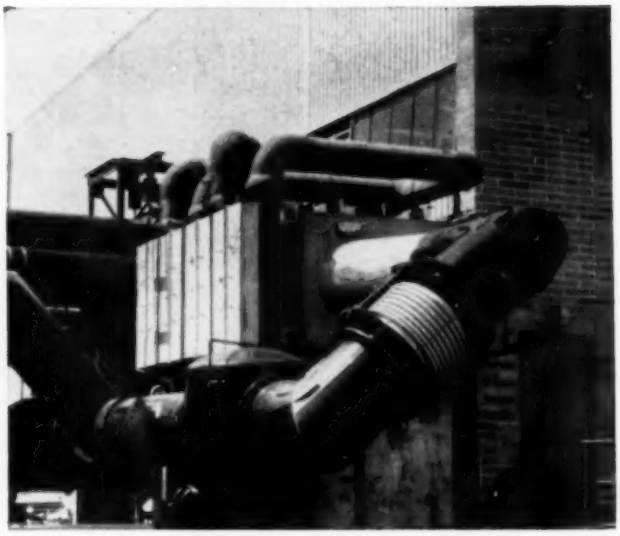
CITY _____ **ZONE** _____ **STATE** _____

See Back Cover for more information on products and services



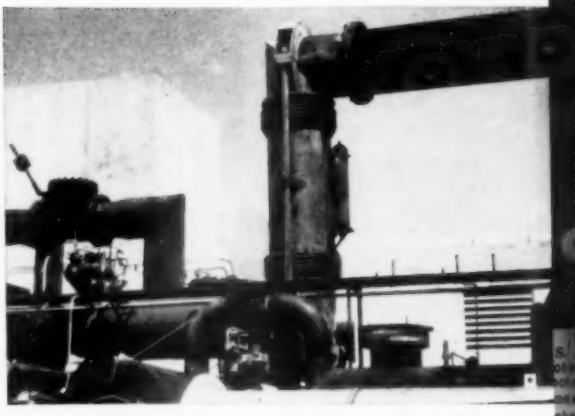
SPECIAL EXPANSION JOINTS

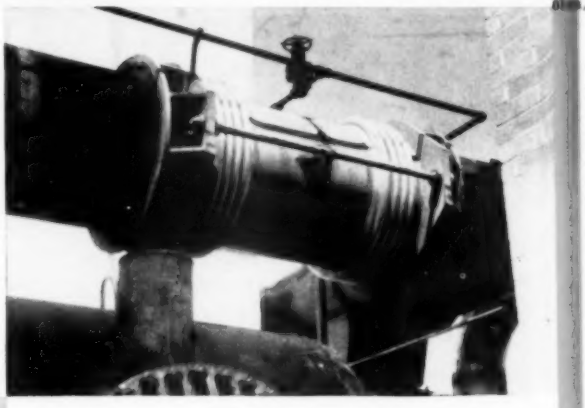
are Second Nature to ADSCO

These photographs show installations of special ADSCO Corruflex Expansion Joints at the Fairchild Engine Division, Fairchild Engine & Airplane Corp., Deer Park, Long Island, N. Y. All joints are designed to absorb lateral motion only, except that the long universal joint, right center, also absorbs any axial growth of its own. All joints are equipped with internal sleeves to smooth out the flow of high-temperature air being carried by the piping systems. They are not standard joints; they are specially engineered, specially manufactured.

A few years ago, when ADSCO was pioneering packless joints for special work, a job like this took considerable engineering and manufacturing time... because it was a new field. But since then, ADSCO has acquired so much experience from so many special orders that special jobs like the Fairchild one are truly "second nature".

Special applications of packless joints are developed carefully but not laboriously. Experience enables ADSCO engineers to get the work out easily and with confidence. Consult them next time you have a special piping problem.





REMEMBER!

Use ADSCO Expansion Joints instead of Pipe Bonds because of these advantages.

1. LESS HEAT LOSS
2. LESS PRESSURE DROP
3. LESS SPACE
4. LESS COST

AMERICAN DISTRICT STEAM DIVISION
YUBA MANUFACTURING COMPANY
20 MILBURN ST. BUFFALO 12, N. Y.

when the chips are down...

S. Nuclear Submarine
o courtesy of
ic Boat Div.,
al Dynamics Corp.
, Conn.

only the *best* is good enough!

When Electric Boat Division was selected to construct America's Atomic Submarine Fleet, Metallo Gasket Company headed their list of outstanding suppliers because Metallo Gaskets have proven their superior sealing efficiency, longer life and ability to retain physical and chemical properties under the most fatiguing service requirements.

Wherever the best in gaskets is required, Metallo Gaskets are specified. Metallo Gaskets are built for specific requirements in strict accordance with customer's specifications or templates in any workable metal. Yet, Metallo Gasket prices are low. Contact Metallo today for complete information and price schedules.

Metallo Engineers will be glad to discuss the factors involved in sealing any type of equipment. Your request for consultation and estimates will not obligate you in any way.

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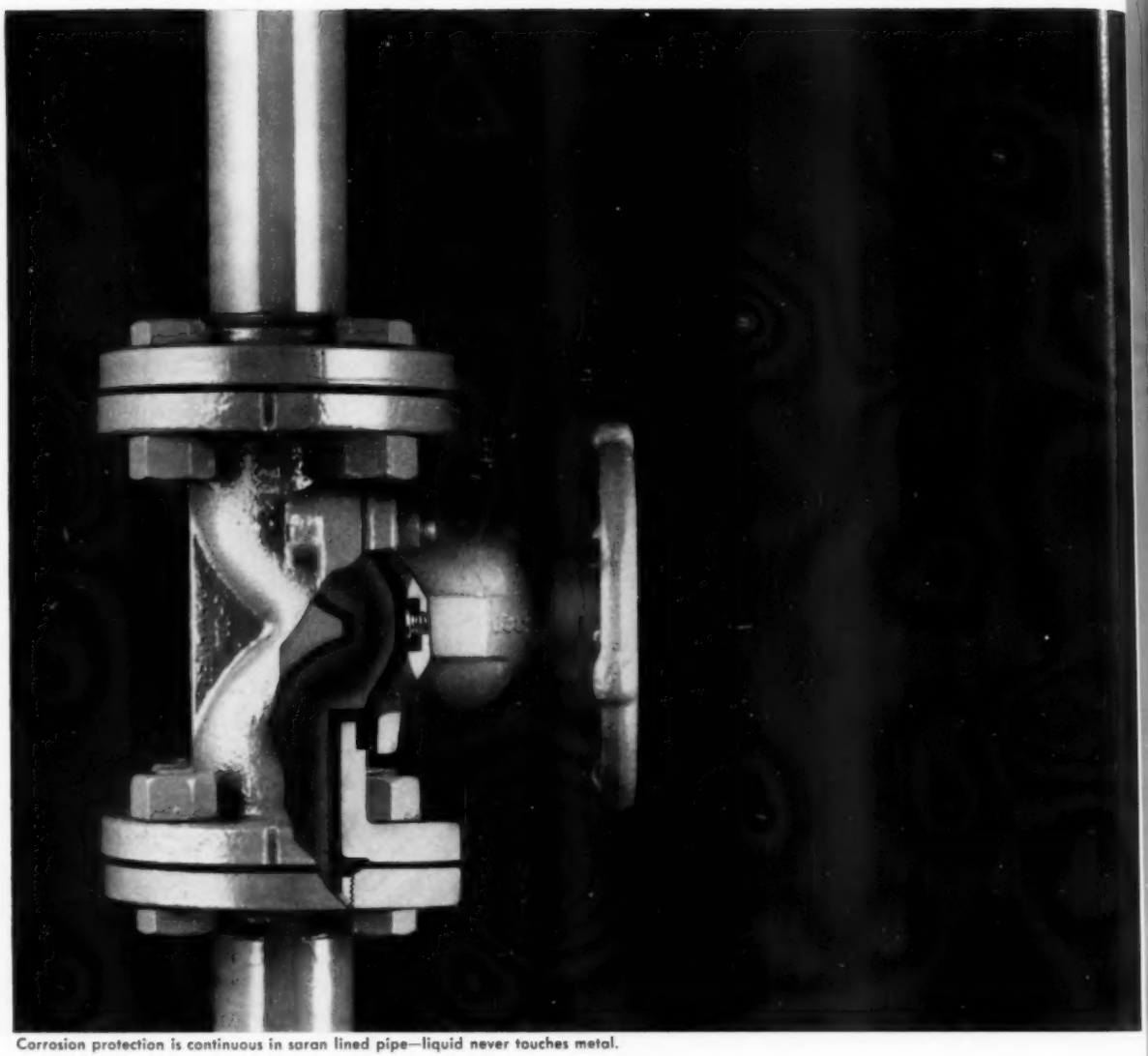

Corrosion protection is continuous in saran lined pipe—liquid never touches metal.

You can see why Saran lined pipe prevents corrosion

Corrosive liquids never touch the rigid steel pipe . . . it's lined with durable saran

You can stop downtime and other corrosion-caused losses by using saran lined pipe.

The saran liner, over which is swaged a steel pipe, gives complete protection from commonly used acids, alkalies and many other corrosive liquids. At no time do these liquids touch the rigid steel pipe, its fittings or valves.

You'll like the labor-saving way it fabricates. Cutting and threading can be done in the field with conventional hand or power tools. And you can hang it in the same manner as ordinary steel pipe.

Saran lined pipe has high bursting strength, withstanding working pressures up to 300 psi. Fittings and valves are available in cast iron or malleable iron for 150 psi working pressures and in cast steel for 300 psi working pressures.

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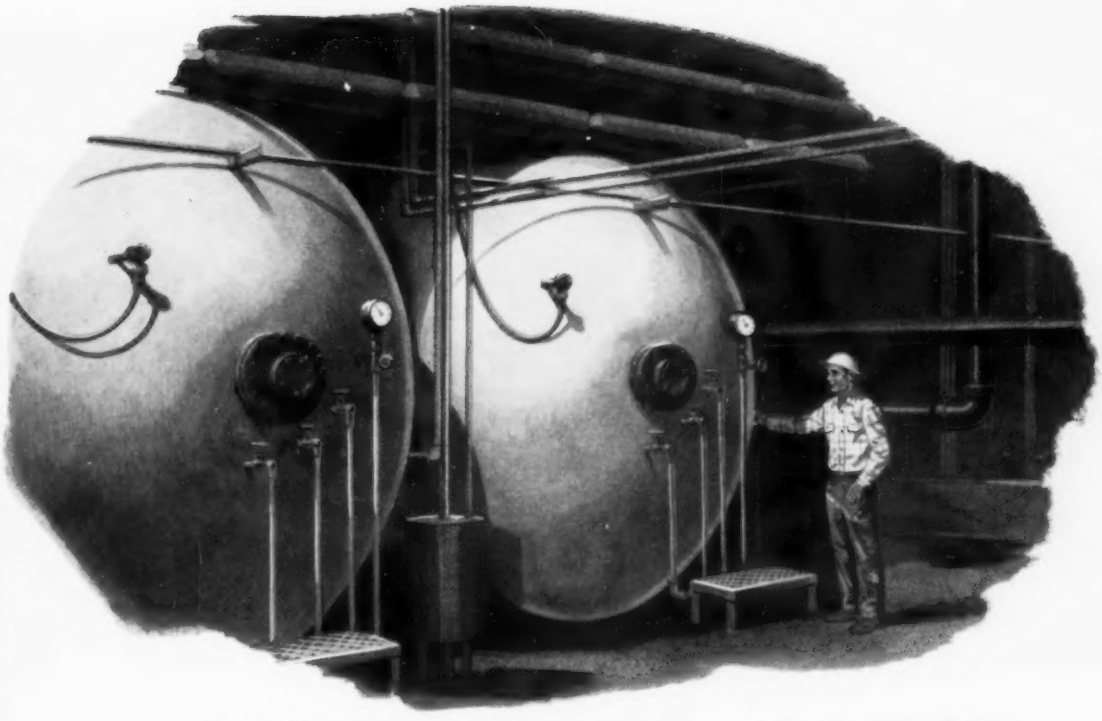
Address_____ City_____ State_____

YOU CAN DEPEND ON DOW



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You'll eliminate trouble, because Aquaness materials work with a wide range of crudes. You don't need to switch chemicals or adjust feed rate when incoming crude varies in gravity and composition.

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SAVES OVER $10,000 PER YEAR WITH AQUANESS COMPOUNDS

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Chemicals for Refining, Gasoline Plants and Oil Transportation

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IT DOESN'T SHOW HERE, BUT...

A Lot of Science

48 *See Back Cover for more information on products and services* PETROLEUM PROCESSING, May, 1957

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Everybody in any phase of the petroleum business, production, research, manufacture, marketi.ıg, is strongly activated by one vital concern—the profitable sale of an end product to the ultimate consumer. And that's exactly what we are working toward, too.

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rapid
short flame combustion
...even on residual fuel oil

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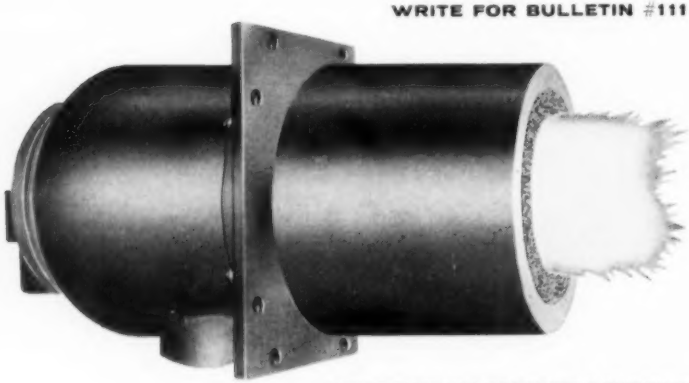

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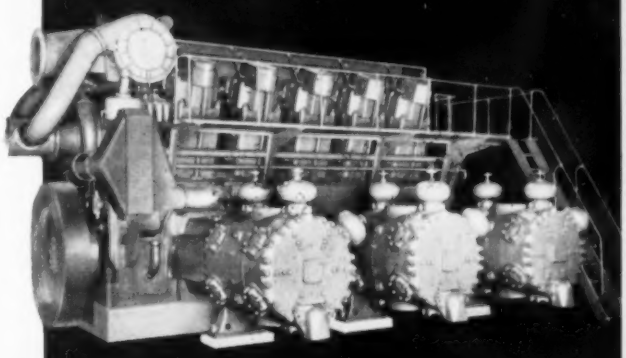
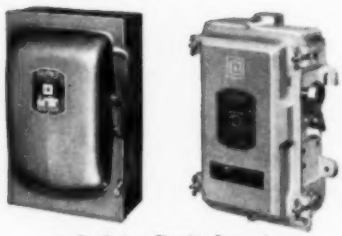
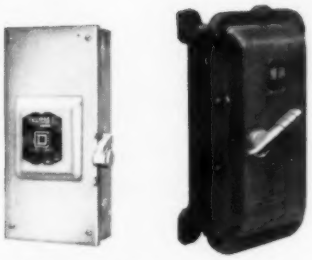


For further details on Series Turbocharging, its unusual advantages and just how it operates, send for new bulletin No. ST-82 . . . or contact the nearest Cooper-Bessemer office.

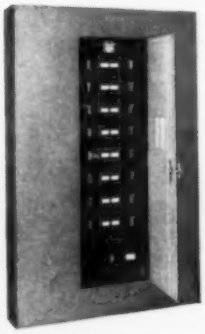


• Safety Switches in General Purpose and Special Purpose Enclosures



• Industrial Circuit Breakers in General Purpose and Special Purpose Enclosures

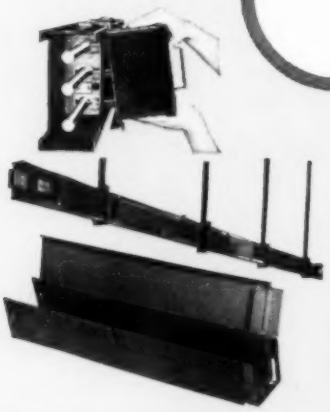
• Voltage Testers



• Fusible and Circuit Breaker Lighting and Power Panelboards

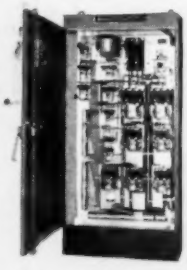
• Power Distribution Switchboards and Switchgear

Wherever Electricity



• Busways and Wireways

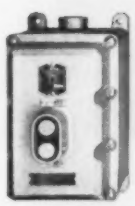
• EC&M High Voltage Synchronous Starters

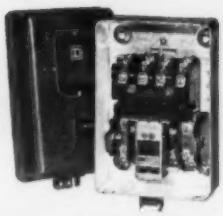


• Special Purpose Control

• Control Centers

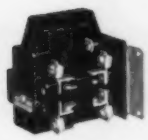
SQUARE D COMPANY



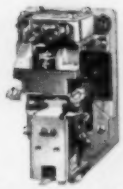


• A.C. Manual and Magnetic Starters in General Purpose and Special Purpose Enclosures

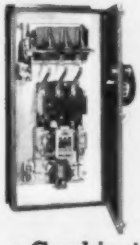
• Limit Switches



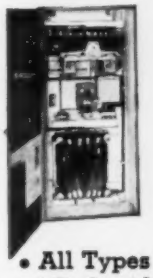
• Control Relays



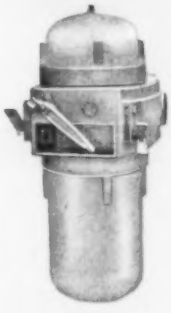
• Timing Relays



• Combination Starters in General Purpose and Special Purpose Enclosures



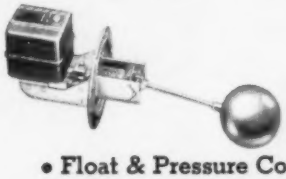
• All Types of Reduced Voltage Starters

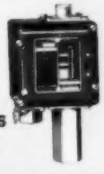


• Starters for Hazardous Locations

• Pushbuttons

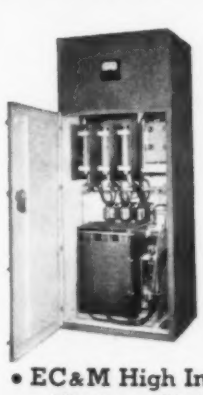
• Oil Field Pumping Plant Panels

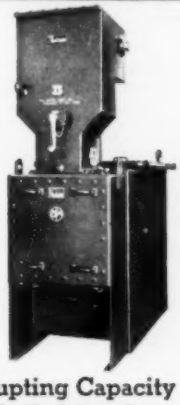




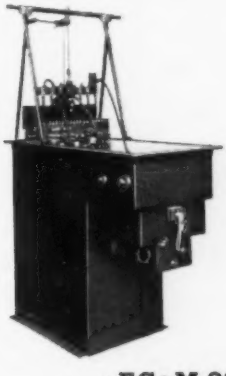
• Float & Pressure Controls for Pumps & Compressors

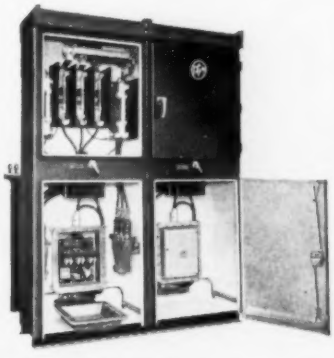
is Distributed and Controlled





• EC&M High Interrupting Capacity Starters. Air-Break *(left)* and Explosion-Resisting *(right)*





• EC&M 2200-4800 Volt Starters for Division 2 Hazardous Locations

DESIGN LEADERSHIP FOR MORE THAN 50 YEARS

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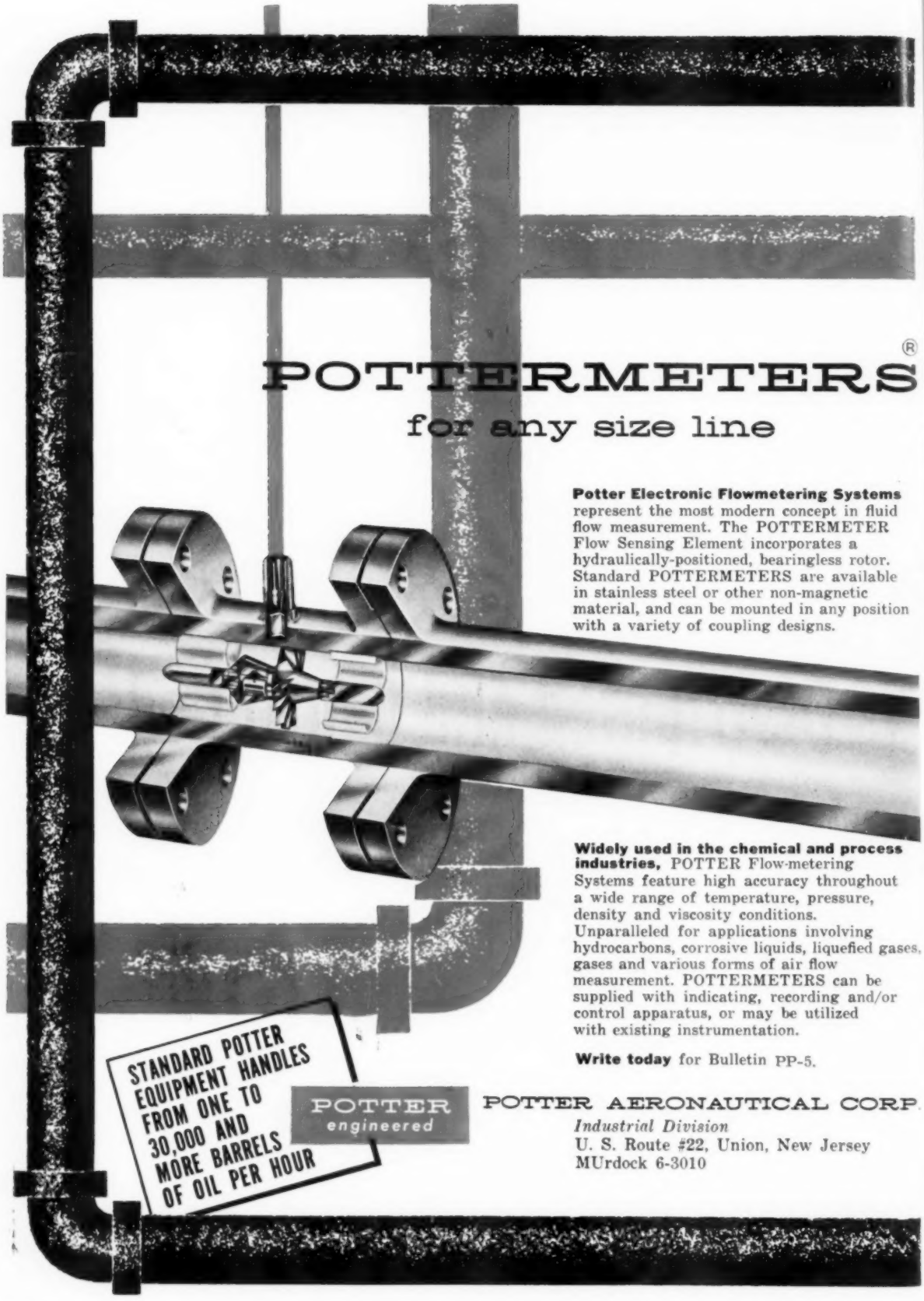
for any size line



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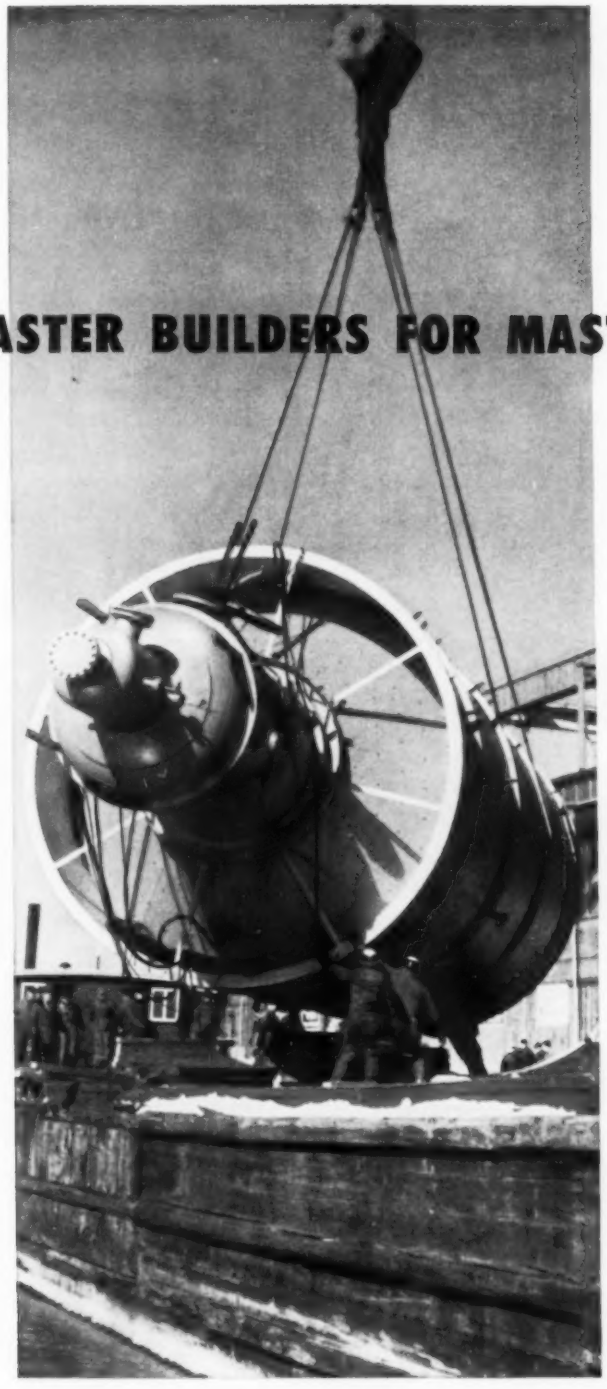

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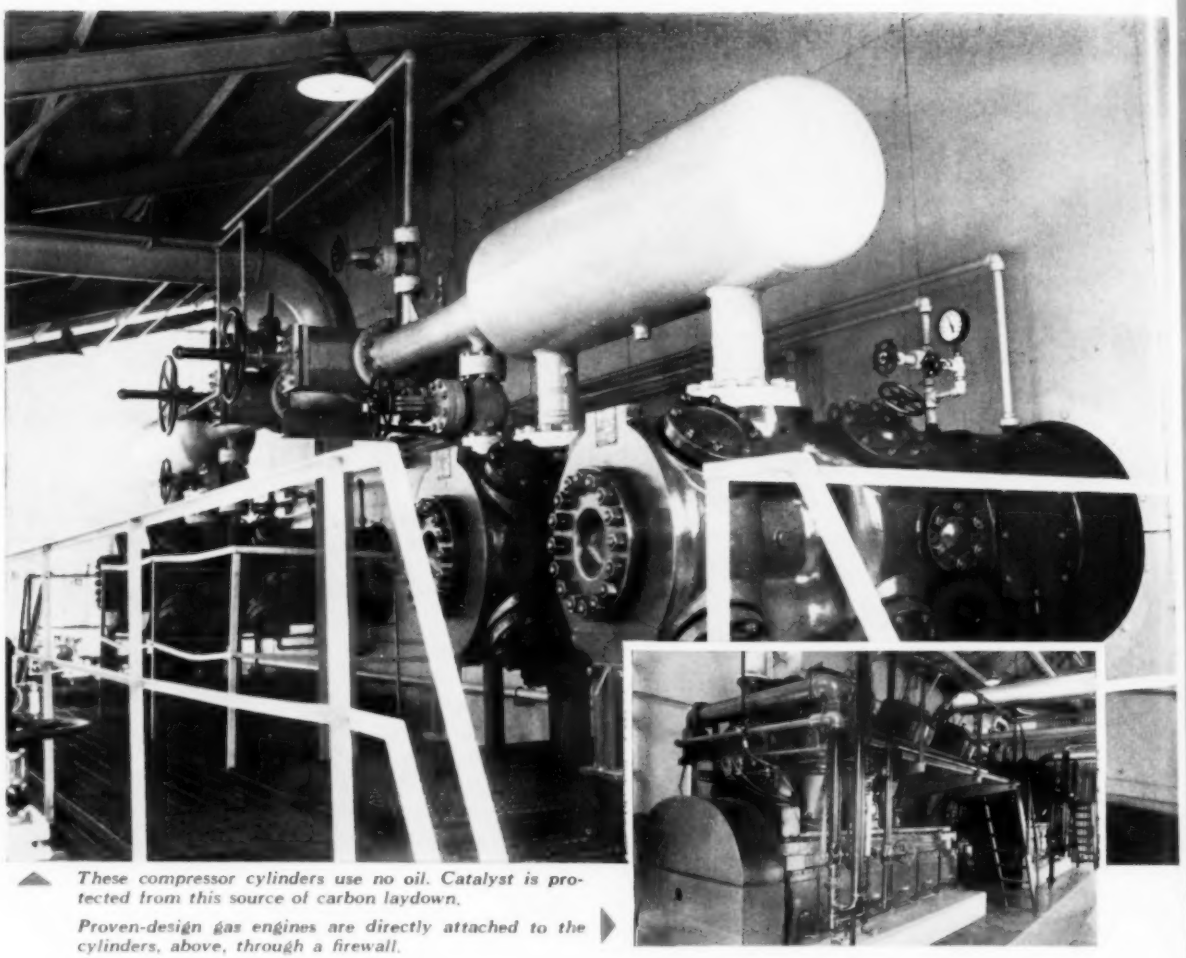

These compressor cylinders use no oil. Catalyst is protected from this source of carbon laydown.

Proven-design gas engines are directly attached to the cylinders, above, through a firewall.

CATALYST LASTS LONGER

with NL compressor cylinders

No oil to carry over in the recycle gas

One feature of the Platforming process, developed and designed by Universal Oil Products Company, is long catalyst life without regeneration. That means a low catalyst cost per barrel of high-octane gasoline. That's why Skelly Oil Company's Platformer at El Dorado, Kansas, uses Ingersoll-Rand compressors with 'NL' non-lubricated cylinders.

In NL cylinders there is no oil to carry over in the recycle gas into the catalyst-packed reactor. Presence of oil would result in carbon laydown (coating which renders catalyst inactive). Oil also causes excessive hydrocracking and formation of undesirable polymers.

The pistons of NL cylinders are supported by graphitic carbon rings sliding in a mirror-smooth bore. Operation is dependable without oil lubrication.

Cylinders are connected to the gas-engine frame by special two-compartment distance pieces that are sealed and vented to allow safe handling of the hydrogen-laden gas.

The two 660-hp KVG compressors handle a total of 73 million cubic feet of gas a day, boosting pressure from 450 psi to 610 psi. Using available gas, their four-cycle, V-angle engines produce low-cost power at all loads.

Ask your I-R representative for complete information on Ingersoll-Rand gas-engine compressors and non-lubricated compressor cylinders. Obviously standard oil-lubricated compressors should be used wherever possible to reduce first cost and maintenance.

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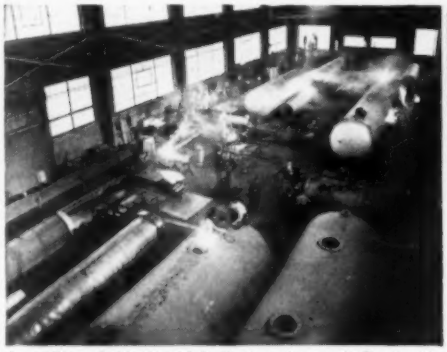
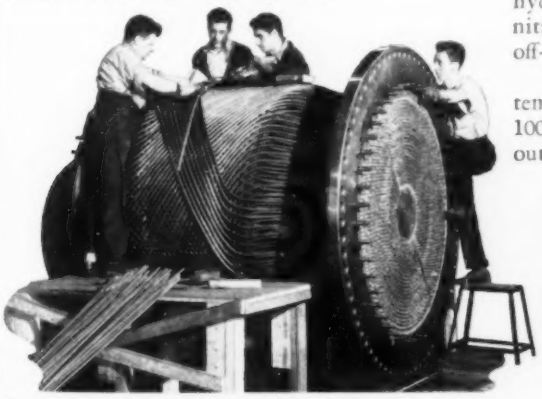
Montreal, Que.

Our widely-experienced technical and manufacturing staff, including design, process, project and mechanical engineers, backed by half a century of "know-how," is at your service to assist you in applying low-temperature technology to your particular requirements. We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components "tailored" to your needs.



A portion of Air Liquide's Engineering and Construction Division fabricating plant at Montreal, Que. Under fabrication here are numerous all-welded stainless steel shells to house component exchangers, vaporizers, rectification columns, etc., of the liquefaction equipment.



The fabrication of an Air Liquide wound tube-type exchanger can involve over 10 miles of intimately interwoven copper tubing to provide the necessary cooling surfaces in this specialized low-temperature equipment.

Air Liquide low-temperature air separation unit for producing high-purity nitrogen.

Similar A.L. unit for recovering hydrogen from coke-oven gas.

Ketona Chemical, at Birmingham, Alabama, has successfully inaugurated the first ammonia plant in this country designed exclusively around coke-oven gas as a source of hydrogen. The low-temperature gas separation units used at Ketona were designed and built by American Air Liquide.

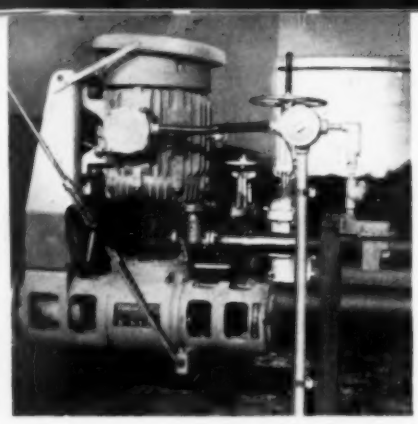
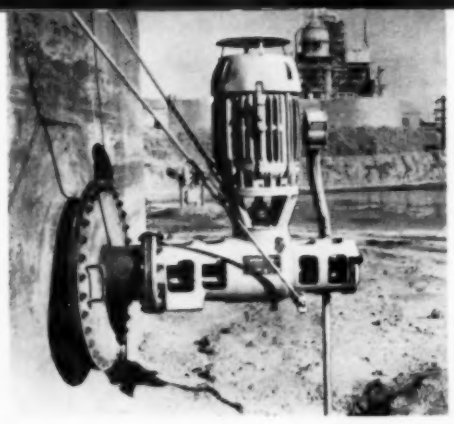
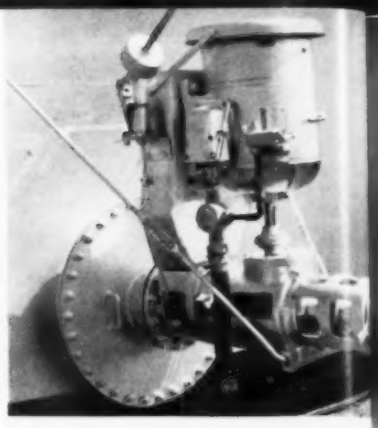
Low-temperature separation processes, for recovering atmospheric and hydrocarbon gases in tonnage quantities, are being used on a rapidly increasing scale in the United States.

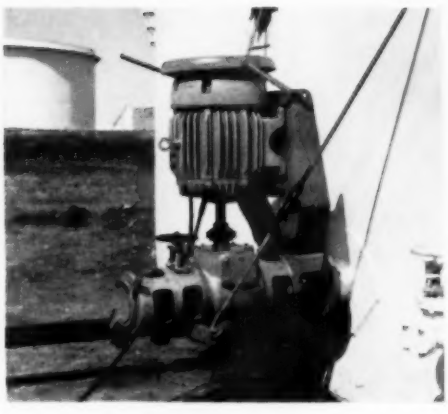
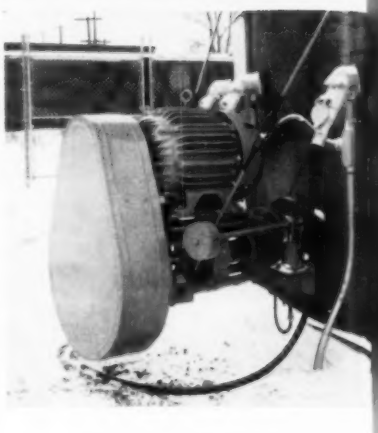
Once confined to the separation of oxygen, nitrogen and the rare gases of the atmosphere, the low-temperature liquefaction process of separation is today successfully producing high-purity hydrogen, pure carbon monoxide, methane, ethylene, propane and nitrogen, from such gaseous mixtures as: natural gas, refinery off-gases and coke-oven gas.

During the past 50 years, Air Liquide (a pioneer in the low-temperature gas separation field) has designed and built more than 1000 hydrocarbon and air-separation plants for industries throughout the world. In the United States it is a leader in this field.

Centre of control panel for a large-tonnage oxygen plant includes a flow sheet for the operator's guidance. Once put "on stream", operation of Air Liquide low-temperature plants is almost entirely automatic.

L'Air Liquide, its affiliates and subsidiaries have offices and plants throughout the world: Algeria, Argentina, Belgium, Brazil, Cameroon, Canada, China, Egypt and Sudan, France, French Congo, French West Africa, Gold Coast, Great Britain, Greece, Indochina, Italy, Ivory Coast, Japan, Lebanon, Luxemburg, Madagascar, Malay States, Morocco, Netherlands, Paraguay, Portugal, Siam, South Africa, South-East Asia, Spain, Sweden, Syria, Tunisia, and the United States of America.

Puzzle: *find the mixer that costs least to operate*

Specifying the *right* mixer for blending, TEL addition, or crude oil sediment control may *look* like a puzzle—but it doesn't have to *be* one.

Simply look for the mixer that gives you *most choice* for the money. That's the one most likely to give you the long-run economy you're seeking.

For example, if corrosion is a problem, you'll want a free hand in choosing the material for the mixer shaft and propeller. It's good to know you can get these parts in *any* machinable metal or alloy (and with special covering, if you want it) —when your choice is a LIGHTNIN Mixer.

Leak-free sealing—Perhaps you've taken a close look at maintenance costs, and decided you'd like a mixer with a rotary mechanical shaft seal instead of a stuffing box. You can get such a seal on any LIGHTNIN Side Entering Mixer (it's saving many oil companies thousands of dollars a year on maintenance). Or you can take your pick of *four* standard packed stuffing boxes, two of which permit repacking without draining the tank.

Choice of power input—What's your preference on mixer drive units? You can choose a highly efficient gear drive, or a lower-cost V-belt drive, for your LIGHTNIN Mixer. On gear-drive LIGHTNINS, you can have a fluid coupling between motor and drive to handle excessively high starting torques.

You want a mixer big enough to handle the job. But you *don't* want to pay for excess horsepower. With LIGHTNINS, you have a *full range* of sizes to choose from —18 basic models, 1 to 25 HP.

Finally, you can order LIGHTNINS with the motor that gives you best service and minimizes your stock requirements: any make with NEMA frame; any current characteristics; any enclosure or insulation.

Get these 20-year savings—You don't pay more for this freedom of choice. You *save*—because you cut your mixer operating, maintenance, and parts-stocking cost for *as long as the next 20 years.*

Start planning *now* for long-term savings in your fluid mixing operations. For quick, competent help, just phone your LIGHTNIN Mixer representative (listed in Refinery Catalog). Or write us direct.

CUT MIXER MAINTENANCE as much as 60% with the new LIGHTNIN cartridge-type rotary seal, optional with LIGHTNIN Mixers. It positively stops leakage, runs for years without adjustment—and slides off the shaft for fast, easy replacement if ever necessary.

Lightnin® Mixers

MIXCO fluid mixing specialists

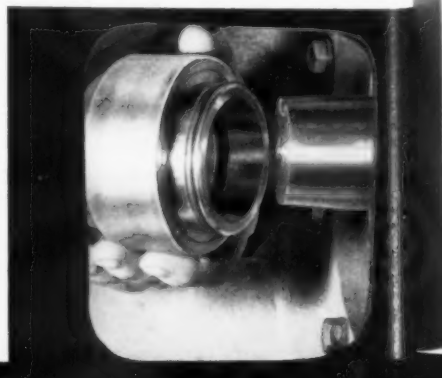
FOR LATEST MIXING INFORMATION and full description of LIGHTNIN Mixers, send for these helpful bulletins:

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering; propeller types: ¼ to 3 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-109 Condensed catalog showing all types
- ☐ B-111 Quick-change rotary mechanical seals for pressure and vacuum mixing
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-e Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.



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See Back Cover for more information on products and services

®Traveloader easily handles bulky heat exchanger bundles with ONE machine and ONE operator

• Traveloader, the unique Baker side-loading fork truck, is ideally suited for removing, storing and installing heat exchanger tube bundles. In the above photo, it is placing a bundle it has just removed from a process system, onto "Christmas Tree" racks in yard storage.

Traveloader is a revolutionary handling machine designed expressly for long, unwieldy, awkward loads. It picks them up from the side, carries them securely on the truck deck, and stacks them to a height of 12 feet. It operates indoors and out, over paved or unpaved roadways—and over highways at speeds up to 30 MPH. Capacities from 10,000 to 12,000 pounds—gas or diesel operated.

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Of all the industries which have contributed to the phenomenal growth of the United States and to its productive capacity both in peace and war, none has been more fundamentally essential than the *Refractories* industry.

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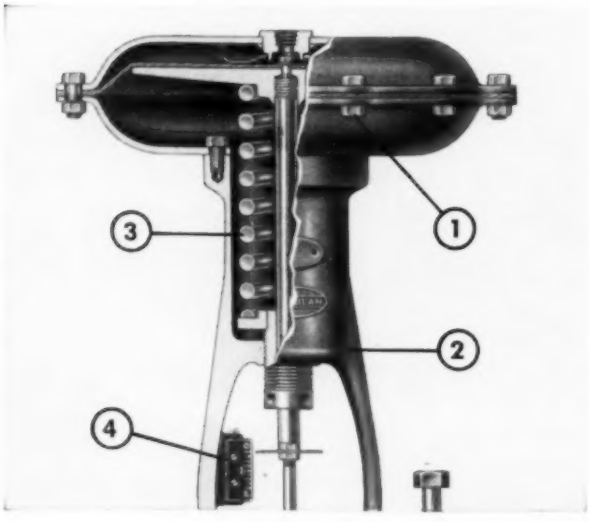
(1) Bolted diaphragm case assures tightness, offers no pockets to accumulate moisture, permits use of flat stock diaphragms in emergency. (2) Cast iron yoke provides inherent rust resistance and rigidity — cannot get out of alignment. (3) Standard 6-30 psi range springs available (at no extra cost) for easy interchangeability with 3-15 psi range. (4) Stroke scale shows actual increments of plug travel. (5) Full specification data on serial plate gives complete information at a glance.



Masoneilan Control Valves Pioneer in

Design To Cut Downtime!

Practical Engineering Builds In Features to Speed Servicing, Reduce Time Losses

Practical engineering aims at reducing maintenance to a minimum and speeding unavoidable servicing. That's one reason Masoneilan Valves find such widespread acceptance — they combine the economies of long life, low service costs and minimum downtime.

Mason-Neilan pioneers many high C_q design features with the *maintenance man* in mind — making his job simpler and more speedily accomplished. Consider, for example, these ten ways in which proper design helps save important money. And for the full story on the complete line ask the office nearest you — or write

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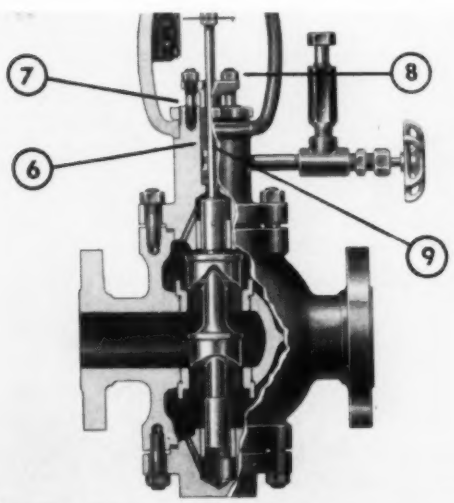
(6) Split-ring, preformed packing assures long service, ease of replacement. (7) Motor is easily removed from bonnet without disturbing packing box. (8) Bolted packing box assures maximum seal with minimum friction; provides visual check on packing life. (9) Superfinished stems move freely, reduce packing box friction, increase packing life. (10) Interchangeability of trim parts assures accurate fit of replacements, speeds conversion for change of process.



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PSC at present has the contract
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COOK Rings *in any case* make for a better seal — but when placed in a *Cook case* assure you the perfectly engineered carbon packing. If you have sealing requirements for non-lubricated compressors, write today for a sample carbon ring, plus literature on Cook's complete line of packing materials. Address C. Lee Cook Company, 942, South Eighth Street, Louisville 3, Ky.

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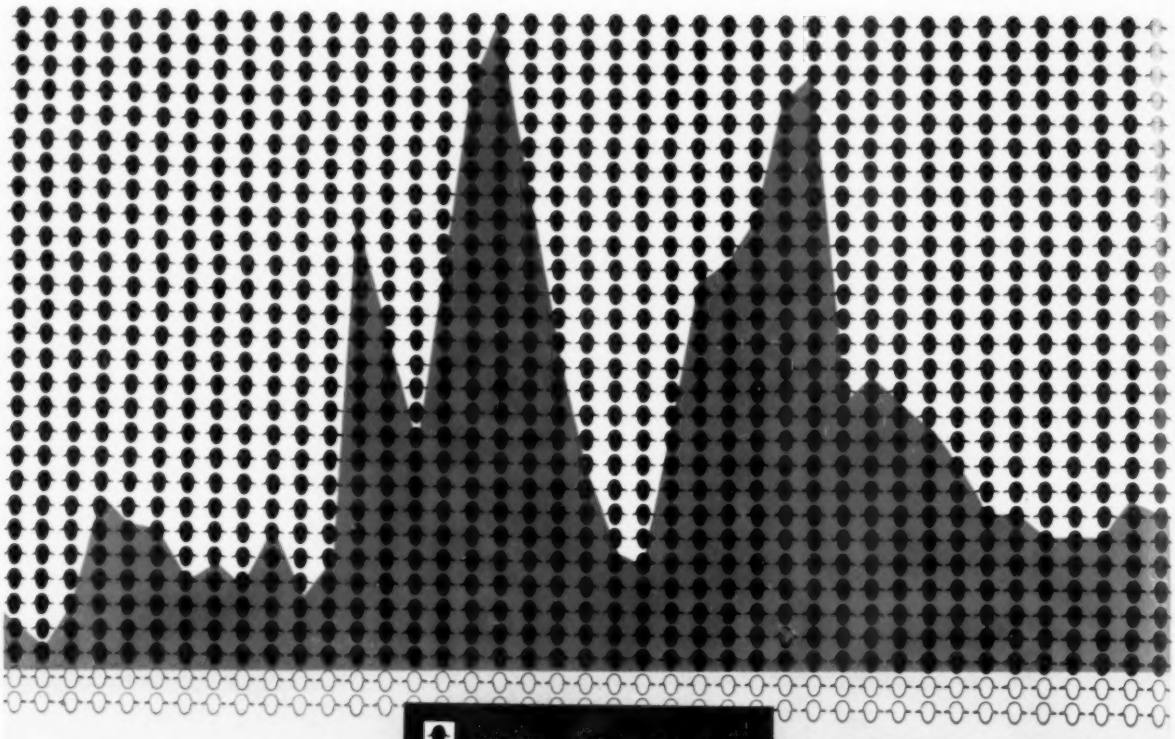
Sealing Pressures Since 1888


Catalytic Maintenance Manpower - in Reserve
Catalytic-supplied Maintenance Manpower - as Needed
Company Maintenance Manpower

HOW HIGH ARE YOUR MAINTENANCE COSTS?

This graph of the actual maintenance manpower load of an operating facility demonstrates how *Catalytic's Contract Maintenance Service* can lower production costs in modern process plants.

This service provides . . .

- Stabilization of plant employment . . .
- Additional skilled labor when needed . . .
- Release of management from costly supervision of non-profit phases of the operation . . .
- Easier control of maintenance costs . . .
- Measurable savings in dollars.

Catalytic's flexible supporting work force responds to peak-and-valley maintenance manpower needs.

Whether you want to assure minimum maintenance manpower costs in an operating plant . . . or to establish flexible, economical maintenance in a new plant . . . you will find *Catalytic Contract Maintenance Service* means more profit and less operating expense.

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CONSTRUCTION COMPANY

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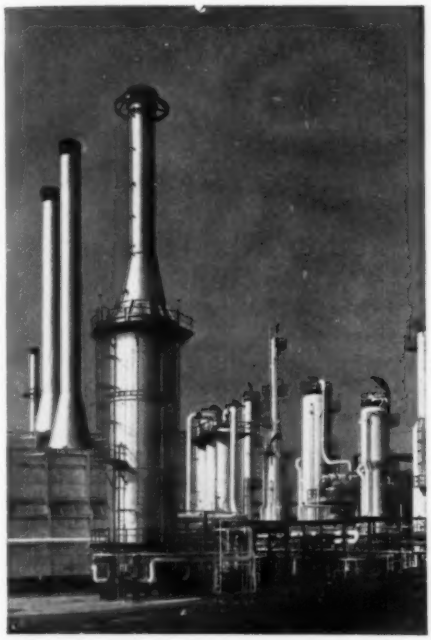
CATALYTIC ON-TIME . . . ON-BUDGET SERVICES for the atomic energy, chemical, petrochemical and oil refining industries • Project Analysis • Process Design • Economic Studies • Engineering • Procurement • Construction • Plant Operation



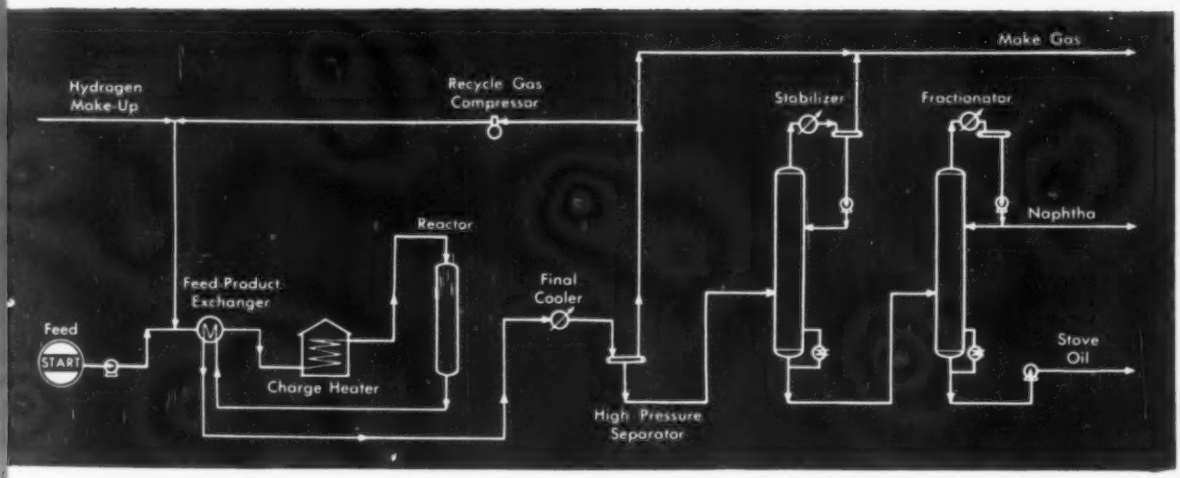
Unifining Unit, Union Oil Company of California refinery, Oleum, California uses Harshaw Cobalt Molybdate Catalyst.

For Hydrodesulfurization

HARSHAW COBALT MOLYBDATE CATALYST

★ **223 regeneration cycles without loss in activity**—a typical performance given by Harshaw Cobalt Molybdate Catalyst, accomplished while treating one of the most difficult charge stocks.

★ **Recording less than 1.0¢/bbl. accumulated costs**—with no indicated loss of activity, Harshaw CO-MO has been full scale tested the longest of any hydrodesulfurization catalyst.



Since you know the critical ingredient of any catalytic hydrogenation reaction is the *catalyst*, the above facts should prompt you to acquire complete details on this premium commodity in the field of catalytic hydrogenation. We shall be happy to point out the many specific advantages that come with using Harshaw Cobalt Molybdate Catalyst and discuss any specific application you may be considering.

Feel free to contact your nearest Harshaw office

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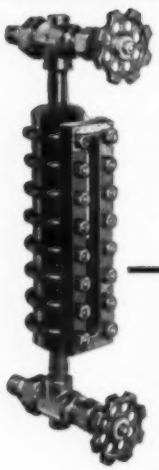
(To obtain more data on advertised products see page 280)

Get the LEVEL READINGS of LIQUIDS THAT BOIL and Flash



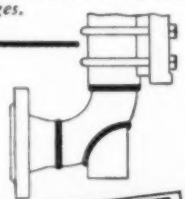
Jerguson Large Chamber Gage

The Jerguson Large Chamber Gage is designed to indicate the level of liquids whose tendency to boil and flash makes an accurate level reading impossible with ordinary gages.

The chamber of this Jerguson Gage is of such large diameter that the level is not badly upset by boiling action of the fluid. This makes possible close level readings, the kind you want and need for accurate control and safety.

You don't have to be satisfied with gages that require guessing at level readings. If liquids boil, install Jerguson Large Chamber Gages and be sure of the liquid level.

The Jerguson Large Chamber Gage is available in reflex and transparent types. Write for full information on this and other Jerguson Gages.



Tapped ¾" pipe threads standard. Available with 2" flanged ends for direct connection to vessel.

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Gages and Valves for the Observation of Liquids and Levels

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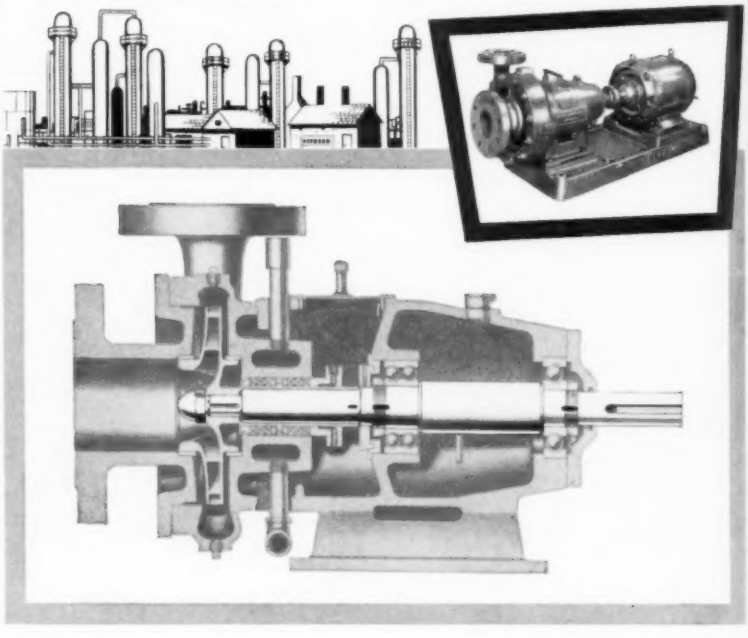
Low Shaft Deflection Means Less Down Time

★ Reduce packing and bearing problems with Dean Brothers centrifugal pumps which are engineered for top performance at 3500 RPM.

Large shaft diameters with short overhang minimize deflection, reduce packing wear and avoid metal-to-metal contact within pump at close running clearances.



★ Low shaft deflection is a must for satisfactory mechanical seal operation. Dean Brothers seals are manufactured to their own specifications. Both pumps and seals are designed for mechanical reliability.

The Best is our Standard

Calculation forms which will aid process engineers in determining pump shaft deflection are available from Dean Brothers Pumps on request.

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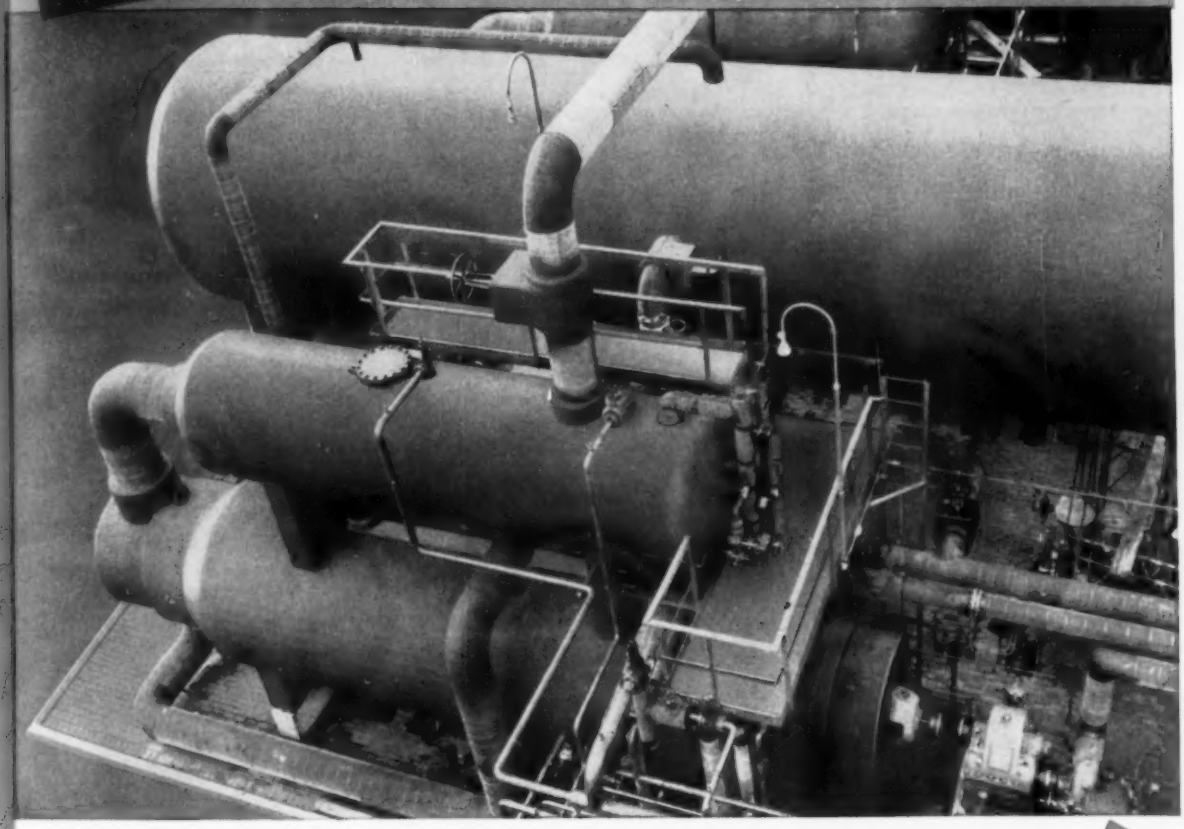
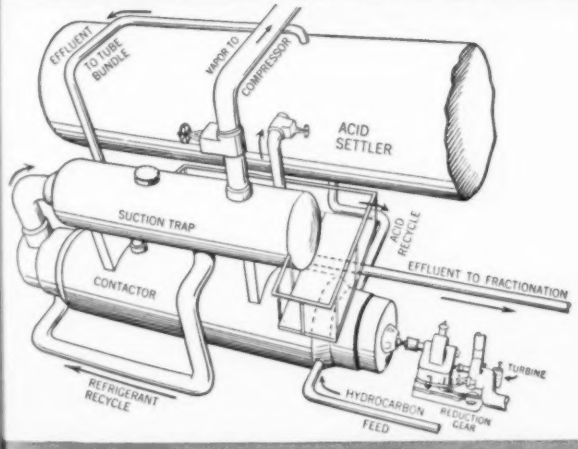
EFFLUENT REFRIGERATION* ALKYLATION





HERE'S WHAT IT LOOKS LIKE...

HERE'S WHY IT PAYS...

This type of reaction system, utilizing the horizontal Stratco contactor and the Stratco effluent refrigeration recycle, produces higher yield, higher quality alkylate with less catalyst consumption and lower capital investment.

21 Contactors now operating with Effluent Refrigeration

20 Under construction.

*Licensed by Stratford Engineering Corporation. We cooperate with your contractor in plant design.

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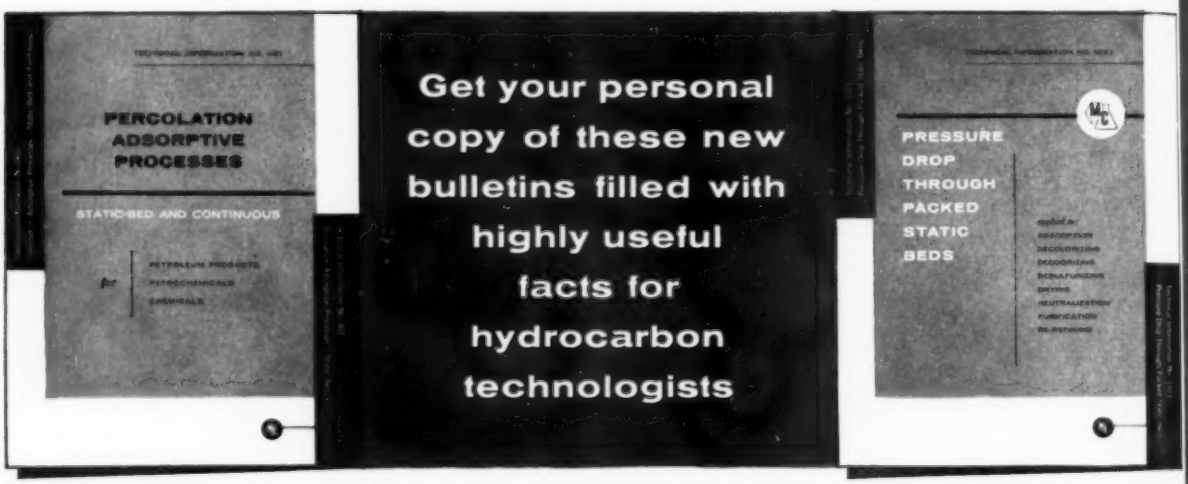
. . . which also means contributing to the literature of the industries we serve

Here's help for the idea man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PRESSURE DROP THROUGH PACKED STATIC BEDS
Get your personal copy of these new bulletins filled with highly useful facts for hydrocarbon technologists

"Percolation Adsorptive Processes . . . Static-Bed and Continuous"

Here's an idea-stimulating, study-in-depth of the potentials of sorptive processing. Twenty-four pages in all, the factual text is supported by process flow diagrams, 14 graphs, charts and curves, and 7 compilations of important tabular data.

"Pressure Drop Through Packed Static Beds"

This bulletin leads you from typical applications through basic design equations to typical design procedure. Charts include friction factor vs Reynolds Number for flow of liquids through packed static beds, as well as calculated values of mean equivalent particle diameter.

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For More Data, see Refinery Catalog, Pages 618-619

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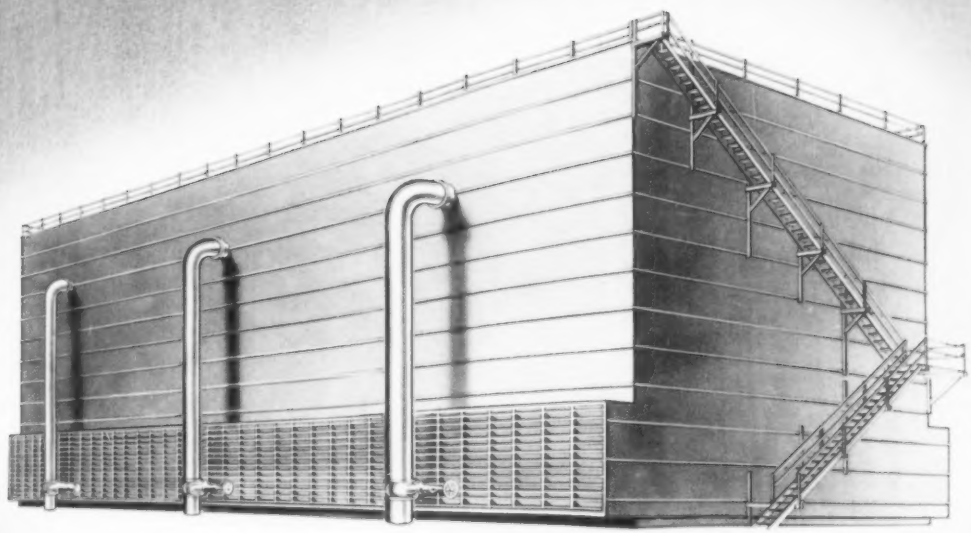
GALLOWAY COUNTER-FLOW COOLING TOWERS



The G. W. Galloway Cooling Tower Division can combine know-how and facilities with its Engineering and Construction Divisions to offer complete turnkey cooling-tower installations—cooling towers, basins, pumps and piping, and electrical wiring.

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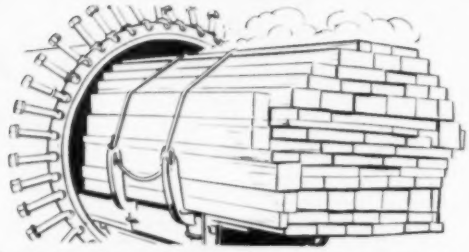
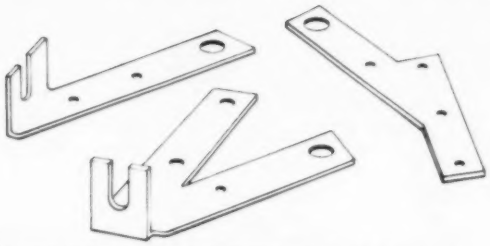
NEW YORK BOSTON CHICAGO TULSA HOUSTON LOS ANGELES

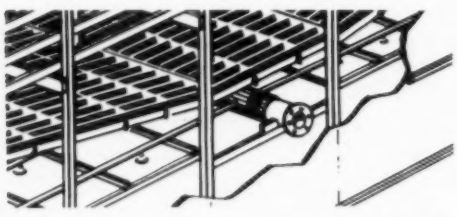
Galloway Offers 5 Key Improvements With a 5-Year Guarantee



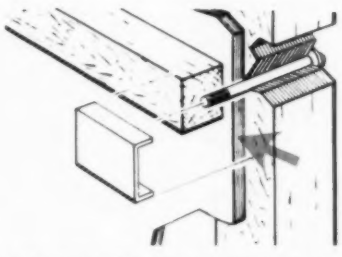
1 DECAY RESISTANT WOOD—Douglas Fir, pressure treated with Chemonite, is used throughout Galloway cooling towers . . . 33% stronger in modulus-of-elasticity than Redwood . . . this material adds years to service life.



2 STAINLESS STEEL RESISTS CORROSION—All metal bolts, straps, and connectors are of stainless steel . . . The "straddle-brace" design eliminates much hardware, so Galloway hardware costs are competitive with less desirable metals.



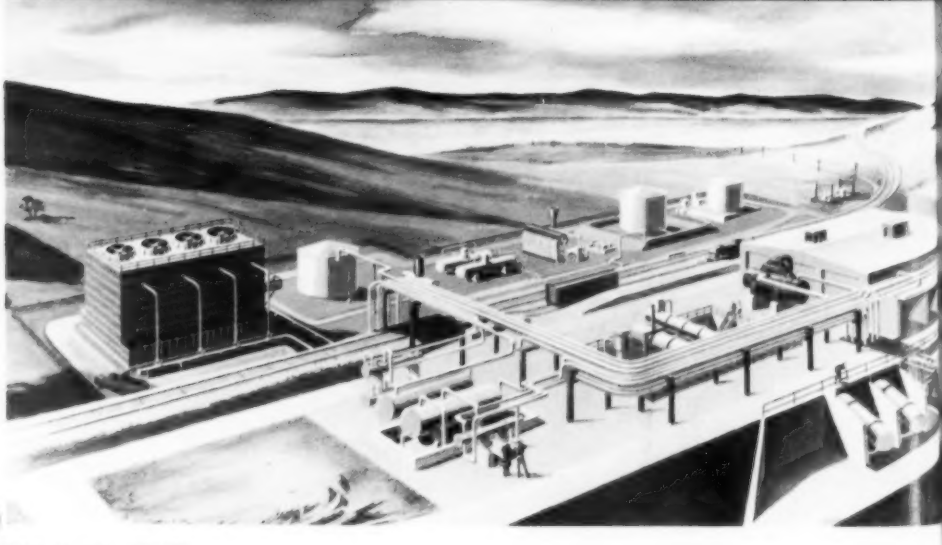
3 A MORE DURABLE DISTRIBUTION SYSTEM — The distribution laterals are impervious to fungus attack, and withstand extreme alternating wet-and-dry operations. Newly designed sloping drift eliminators provide improved access to the distribution system, and allow greater air velocities within the tower.



4 FIRST LEAK-PROOF EXTERIOR SHEATHING—Improved appearance is a Galloway tower feature with "sandwich panel" sheathing. Bonded between leak proof plastic sheets, this patented material waterproofs the tower inside and out.

5 GALLOWAY-WESTINGHOUSE VERTICAL GEARMOTOR—Specially designed for efficient use in cooling towers, this moisture-proof power unit eliminates right angle gears, shafts and flexible couplings, thus minimizing mechanical problems.

Multi-million dollar propulsion system component development facilities, including the Galloway cooling Tower, for United States Air Force. G. W. Galloway Co. Engineers and Constructors



G. W. GALLOWAY CO.

Engineering DESIGN FABRICATION CONSTRUCTION

Home Office — ARCADIA, CALIFORNIA

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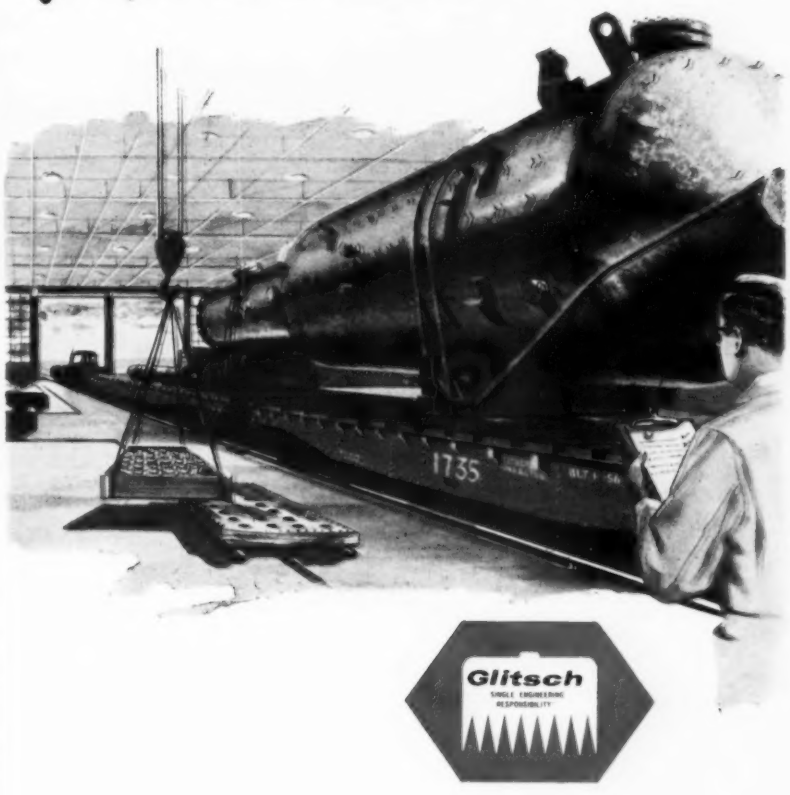
Easy, Quick to Check Out.... Place a single purchase order for pressure vessel and internals



Many operators place a single purchase order with Glitsch for both the tower internals and the pressure vessel itself in order to save time and money and to afford a more efficient operation. One inspector can check out the entire job—which also saves time and expense. Glitsch is completely equipped to fabricate any design and type of pressure vessel—built exactly to our customer's process specifications—according to all code requirements, at competitive prices, and with a quality of workmanship that is unexcelled by any other plant in the industry. A complete set of drawings is furnished with every job and the services of Glitsch field personnel are always available when required. No job is too small nor too large; we can fabricate vessels as large as 12½′ x 162′, completely equipped with walkways and platforms.

Calling in a Glitsch man at the earliest possible stages is one way you can be sure that regardless of the process, your project will be expertly engineered and fabricated. Your nearest Glitsch representative will be glad to give you illustrated literature and additional details on this and other Glitsch equipment without obligation. Fritz W. Glitsch & Sons, Inc., P.O. Box 6227, Dallas, Texas.

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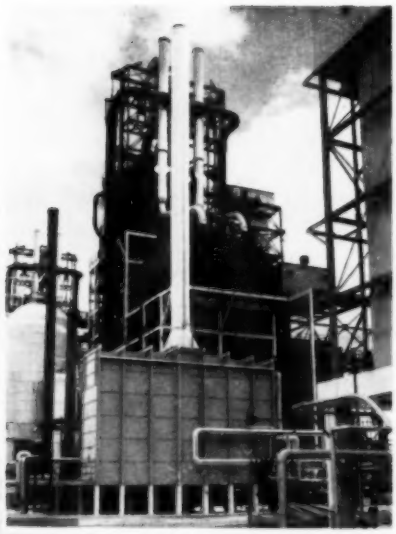
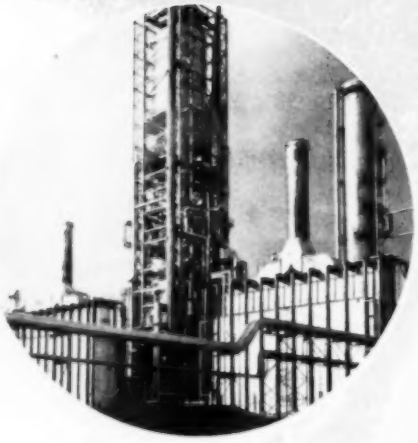
Glitsch Packaged Units —Towers and Internals

See Back Cover for more information on products and services



every BORN heater is special



When you specify a BORN Heater, it's with confidence that it will do the job you want. Every BORN Heater is individually suited to the customer's requirements. That heater is **specially** made for you. That's the reason BORN heaters are specified time and again by clients whose names are the Who's Who of the Oil Industry.

For low first cost . . . high fuel efficiencies . . . close control . . . economical, trouble free operation . . . and exclusive safety features . . .

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Manufacturers of Direct-Fired "UPFLO" Heaters

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Brander & Cia. S. A.
Tacuari 310
Buenos Aires, Argentina
Premafrance
36 Boulevard Gouvion St. Cyr
Paris 17, France

"PRESCRIPTIONS" FOR YOUR REFINERY PROBLEMS!

... by TRETOLITE

SALT

TRETOLITE CHEMICAL DESALTERS

Used daily by refiners all over the world . . . currently desalting over 1½ million barrels per day, at an average cost of .0013 cents per barrel, with salt removals in the 95 to 100% range. Tretolite Desalting can be acquired by purchase, rental or owner-built options.

CORROSION

KONTOL CORROSION INHIBITORS

Applicable to practically every refinery system requiring internal corrosion protection. Test coupons, application advice and other specific assistance—as well as the Tretolite research and laboratory facilities—are always available to you.

COPPER CONTAMINATION

KUPLEX METAL DEACTIVATOR

A metal deactivator for refined hydrocarbon products such as gasoline, kerosine, jet fuel, diesel, furnace and turbine oils. Prevents the deterioration of these products caused by metal catalyzed oxidation.

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For the correction of a wide variety of emulsion problems that plague most refineries: tank bottoms disposal, refinery wastes, various treating procedures. Also available as fuel emulsion preventives, to prevent the emulsification of burning oils and diesel fuels.

Ask the Man in the Red Car

For Further Information on These or Any Other Tretolite Products, ask your Tretolite Refinery Service Man.

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A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, Calif.

Chemicals and Services for the Petroleum Industry

Desalting • Demulsifying • Corrosion Inhibiting • Scale Prevention • Fuel Oil Additives • Water De-oiling • Metal Deactivators

NOW!... for your refinery

A 3-WAY CHOICE

for putting the

TRETOLITE DESALTING PROCESS

in operation

advantages of the

TRETOLITE DESALTING SYSTEM

- *Proved Performer.*
  Used to purify 1½ million barrels every day.
- *95 to 100% Salt Removal.*
- *Average Chemical Cost of 1.3 mills per Desalted Barrel.*
- *Automatic Operation.*

Tretolite desalting, the first all-chemical desalting process, is now available to you in a choice of plans, one of which is certain to fit into your operation and financial policies:

1 Standard Proposal

The Tretolite Company furnishes a list of the equipment required, instructions for installation and, working drawings, designed to tie in with the flow stream in the customer's refinery. Data on the rate of Tretolite injection for optimum desalting results, operating instructions, temperatures, pressures and water requirements are also included. Tretolite Refinery Service Engineers check construction procedure to insure that installation is according to specifications; they also assist with start-up and make periodic visits after the unit is in regular operation.

2 Outright Purchase

The Tretolite Company ships the desalting plant equipment to the refinery. Erection is then carried on by refinery personnel or by an erector of the customer's choice. Inspections during construction, start-up assistance, and periodic inspections are provided by the Tretolite Refinery Service staff as in plan No. 1. When the desalting plant is ready to go on stream, Tretolite Refinery Service Engineers supervise an acceptance test run to meet the guarantee of minimum chemical requirements and salt removal efficiency as set forth in the contract.

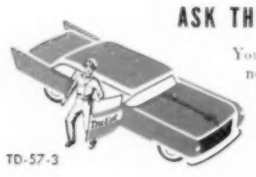
3 Rental with Option to Purchase

The rental plan is similar in all general respects as to instructions, supervision and materials furnished in plans No. 1 and No. 2. After acceptance requirements have been fulfilled, the pre-determined annual rental fee is payable according to the payment option selected by the customer.

After the plant has been operated for three years on the rental basis, the customer has the option of purchasing the equipment for a pre-determined price. (This price is reduced after each year's rental.) After a unit has been used on a rental basis for seven years, the annual rental fee is reduced about 50%.

For additional information,

ASK THE MAN IN THE RED CAR



TD-57-3

Your Tretolite Refinery Service Engineer will gladly give you complete information on the various ways of acquiring Tretolite Desalting equipment, as well as operating and performance data on plants currently in service.

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DESALTING • DEMULSIFYING • CORROSION INHIBITING
SCALE PREVENTION • FUEL OIL ADDITIVES
WATER DE-OILING • METAL DEACTIVATORS

NOW... pre-mixed additives offer new convenience to refiners

NEW combination prevents gel-clogging in fuel lines as well as sludge-plugging of filters, screens and nozzles

Now Du Pont offers the protective qualities of two additives, pre-mixed for your convenience: Fuel Oil Additive No. 2 (FOA-2) and Du Pont Metal Deactivator (DMD). Respectively, they provide outstanding stabilizing and dispersant action, and protection against the effects of copper contamination.

The result is a solution that guards against practically all the major chemical causes of oil burner troubles and failures.

The new additive is available in two different concentrations. One, FOA-208, is composed of 8% DMD and 92% FOA-2. The other, FOA-212, is a 12% DMD, 88% FOA-2 solution.

Stabilizer and dispersant

The stabilizing action of Du Pont FOA-2 retards the formation of insoluble residues during bulk storage and in customers' tanks. The dispersant action of FOA-2 reduces the size of the particles in any residues that may form.

In these two ways, it prevents a build-up of sludge that causes clogging of filters, screens and nozzles.

Prevents gel-clogging

Clogged fuel lines are generally due to the formation of a gelatinous material. This is frequently caused by contamination from copper in screens, feed lines, valves and other fuel handling equipment. DMD prevents this effect of copper contamination . . . thus preventing the need for many service calls due to gel-clogged fuel lines.

Now, it is possible for refiners to add this complete three-way protection in a single operation. For best results, Du Pont FOA-208 or 212 should be added to freshly prepared stocks at the refinery.

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Cleveland 15—25 Prospect Ave. ... SUperior 1-1363
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Houston 2—705 Bank of Commerce Bldg. .... CApitol 5-1151
Los Angeles 17—612 So. Flower St. . MAdison 5-1691
New York 20—1270 Ave. of the Americas ..... COlumbus 5-2342
Philadelphia 2—3 Penn Center Plaza . LOcust 8-3531
Pittsburgh 22—1 Gateway Center .. ATlantic 1-2933
San Francisco 4—111 Sutter St. .... EXbrook 2-6230
Seattle 3—4003 Aurora Ave. ..... MElrose 6977
Tulsa 1—1811 So. Baltimore Ave. .... LUther 5-5578
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In Other Countries—Petroleum Chemicals Division, Export Sales, 7496 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962

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See Back Cover for more information on products and services

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Petroleum Processing's

1957 Refining Industry Report

74 pages of useful reference information in three sections:

- **Complete refinery directory,** for both United States and Canada, including crude and principal process unit capacities, principal product volumes, key personnel, geographical location, and mailing address for each of 359 plants, as well as key personnel, geographical location, and mailing address of company home offices **starts on p. 81**

- **Glossary of 168 Refining Processes,** including a complete index (pg. 149), 74 schematic flow charts, 1,000 literature references, and a coded cross-reference system enabling you to find which engineering, design, and construction firms furnish specific services for each process **starts on p. 97**

- **Who's Who in Refinery Service Firms,** with the coded cross-reference system correlating this directory with the Process Glossary. This listing tells the type of service each firm provides, who to contact for details, and addresses of home and/or branch offices **starts on p. 150**

CAPSULE SUMMARY . . . 1957 Refining Industry Survey

(in b/d as of April 1, 1957—based on following 16 pages of detailed survey information)

	In Operation			Planned or Building[1]		
	U.S.	Canada	Total	U.S.	Canada	Total
Number of companies	248	26	274	22	2	24
Number of plants	315	44	359	23	2	25
Crude distillation:						
Units	311	43	354	19	2	21
Capacity	8,738,778	697,800	9,436,578	330,000	40,000	370,000
Catalytic cracking:						
Units	158	24	182	8	2	10
Capacity	3,587,903	319,287	3,907,190	209,300	8,100	217,400
Thermal cracking:						
Units	125	14	139	2	1	3
Capacity	1,328,004	60,300	1,388,304	2,000	1,600	3,600
Catalytic reforming:						
Units	151	21	172	45	7	52
Capacity	1,110,624	90,425	1,201,049	366,230	27,550	393,780
Thermal reforming:						
Units	34	3	37	—	—	—
Capacity	219,992[2]	17,000	236,992	—	—	—
Hydrogen treating:						
Units	74	11	85	36	5	41
Capacity	756,810	40,175	796,985	403,825	41,500	445,325
Isomerization:						
Units	6	—	6	2	—	2
Capacity	12,950	—	12,950	4,600	—	4,600
Coking:						
Units	42	5	47	3	—	3
Capacity	422,720[3]	13,097	435,817	28,300	—	28,300
Visbreaking:						
Units	38	10	48	1	1	2
Capacity	369,500[4]	64,000	433,500	3,000	3,000	6,000
Polymerization:						
Units	144	19	163	6	2	8
Capacity (b/cd product)	178,275	21,584	199,859	9,065	670	9,735
Alkylation:						
Units	67	2	69	15	—	15
Capacity (b/cd product)	256,620	2,250	258,870	51,430	—	51,430[5]

(1) Includes complete new plants, new units, and capacity expansions (design or estimate) in existing units.
(2) Thermal reforming capacity is for 33 U.S. units: no data available on 34th unit.
(3) Coking capacity is for 41 U.S. units: no data available on 42nd unit.
(4) Visbreaking capacity is for 34 U.S. units: no data available on other four units.
(5) Alkylation capacity under construction includes two expansions that totalled 5,600 b/d.

THE table above summarizes the detailed information in the 16-page survey of U.S. and Canadian refining which starts on page 81.

Six highlights of this survey follow:

1—Catalytic cracking still dominates the existing process capacity, with thermal cracking second, and catalytic reforming third.

2—In new construction, however, catalytic reforming and hydrogen treating are both rapidly outstripping catalytic cracking capacity.

3—Total new construction currently underway, or planned, for U.S. and Canada will cost an estimated $500-million.

4—There are today 32 idle plants in the U.S., with an estimated capacity of 110,000 b/d, and two in Canada with 1,000 b/d capacity.

5—In addition to these completely shutdown plants, there is an estimated 225,000 b/d of idle capacity in the U.S. due to partial shutdown in existing operating plants.

6—Eight U.S. plants, shutdown in recent years, are being dismantled. The data in this directory has for the most part been obtained directly from the petroleum processing companies in an extensive survey. The Editors of PETROLEUM PROCESSING are grateful for the wide cooperation given by the petroleum industry. In those cases where information was not obtained at deadline time, the Editors have relied on previously published data from reliable and authoritative sources.

Petroleum Processing's

1957 Refinery Directory

United States and Canada

A comprehensive survey of plant locations, process capacities, and product outputs—compiled by the editors of Petroleum Processing

How to Use this Directory

- **Companies are arranged** alphabetically. Plants within a company are arranged alphabetically by state, by location within that state.
- **Key numbers** have been assigned each company, and the same number plus a suffix number for each plant of a company. These numbers are used to identify plants on a 35x22-in. "Map of U.S. and Canadian Refineries." (Available as Reprint R46, 25¢ a copy.)
- **Asterisk (*) indicates** information from published sources—not verified by the company during the PETROLEUM PROCESSING survey.
- **Capacities and volumes** are given in barrels per calendar day (b/cd) unless otherwise specified.

U. S. Refineries

A

ADVANCE REFINING CO 1
PO Box 407, Centralia, Ill; ph 6730-6739. M. Taxman, Pres.

• Centralia, Ill 1-1
10th and Walnut Sts, Centralia; mail and ph as above.
Crude oper cap 2500.
Fuel proc unit—Cycloversion 650.
Key personnel—M. Taxman, Pres & genl mgr; P. Hughes, rfy supt.

AEREX CO, INC* 2
Bloomfield, N Mex—inactive.

AETNA OIL CO 3
1202 S 3rd St, Louisville, Ky; ph ME 5-6321. Parent, Ashland Oil & Refining Co (Ky).

•Louisville, Ky—idle 3-1
4510 Algonquin Pkway, Louisville, Ky; ph Spring 6-2427.
Crude oper cap 10,000 idle.
Fuel proc unit—therm crack 5000.
Key personnel—E. E. Van Buren, rfy supt.

ALLBY ASPHALT & REFINING CORP* 4
Joint operation of Byerlyte Corp. & Allied Materials Corp, announced 1954

• Hammond, Ind 4
Crude oper cap 7500.

ALLIED MATERIALS CORP* 5
300 Braniff Bldg, Oklahoma City 2, Okla; ph REgent 9-0592. C. W. Barbour, Pres & genl mgr. Affil, Allby Asphalt & Refining Corp.

• Stroud, Okla 5-1
Box 516.
Crude oper cap 3000.

AMERICAN BITUMULS & ASPHALT CO 6
100 Bush St, San Francisco 20, Calif; ph GArfield 1-6653. Parent, Standard Oil Co (Calif).

• Mobile, Ala 6-1
Blakely Island (Mobile), PO Box 1069, Mobile; ph HEmlock 8-1641.
Crude oper cap 4773 oper, 1227 idle.
Prin prod—asphalt 3282.
Key personnel—W. G. Cole, rfy mgr; J. L. Turner, supt of rfy opers.

• Baltimore, Md 6-2
1955 Chesapeake Ave (PO Box 1955) Baltimore; ph Curtis 7-2800.
Crude oper cap 3910 oper, 3570 idle.
Prin prod—asphalt 3035.
Fuel proc unit—visbreaking, operative only when not running crude to asphalt.
Key personnel—W. T. Holcomb, rfy mgr; A. F. Weidenham, rfy supt of opers.

• Cincinnati, Ohio 6-3
Brower Rd, Columbia Park, Hamilton Cty, Ohio; PO Box 14, Western Hil Sta, Cincinnati 14; ph Willow 1-4400.
Crude oper cap 5476 oper, 4524 idle.
Prin prod—asphalt 4096.
Key personnel—E. Daniels, rfy mgr; H. H. Eckert, rfy supt of opers; W. H. Scogin, Jr, rfy engr.

• Portland, Ore 6-4
5501 NW Front Ave, Portland 7; ph Capitol 2-1668.
Crude oper cap 3755 oper, 2745 idle.
Prin prod—asphalt 2320.
Key personnel—N. H. Townsend, rfy mgr; R. McDonough, rfy supt of opers; L. A. Heinz, rfy engr.

• Richmond Beach, Wash 6-5
Snohomish Cty, 15 mi N of Seattle, off US Hwy 99; PO Box 125, Richmond Beach; ph Lincoln 3121.
Crude oper cap 1237 oper, 2263 idle.
Prin prod—asphalt 956.
Key personnel—W. W. Trudgeon, rfy supt.

AMERICAN GILSONITE CO 7
134 W Bdwy, Salt Lake City 1, Utah; ph EMpire 3-2608. E. H. Owen, secy-treas. Parents, Standard Oil Co (Calif) & Barber Oil Corp, NYC.

• Gilsonite, Colo 7-1
Oper cap 700 t/d (3850 b/d) gilsonite.
Prin prods—mtr gaso 1300, coke 250 t/d.
Fuel proc units—Platformer 1700, coker 3500 fresh & 7000 recycle.
Key personnel—L. P. Morris, mgr-opers; J. L. Boyce, Jr, rfy supt; J. H. Henderson, Jr, chf engr-opers.
Constr plans—11,500 b/od delayed coker by Foster Wheeler, onstream May-57; 1700 b/od Platformer by H. K. Ferguson, onstream May-57.

AMERICAN LIBERTY OIL CO* 8
3417 Gillespie (Box 8105), Dallas 5, Tex; ph Logan 5251. Bought by American Petrofina, Inc, Apr-57.

• Mt Pleasant, Texas 8-1
Box 1011, Mt Pleasant.
Crude oper cap 28,500.

AMERICAN MINERAL SPIRITS CO 9
230 N Michigan Ave, Chicago 1, Ill; ph Andover 3-3050. E. M. Toby, Pres. Parent, The Pure Oil Co.

• Toledo, Ohio*—planned 9-1
ODM FTA approval for aviation alkylation unit.

AMERICAN OIL CO 10
555 Fifth Ave, New York 17, NY; ph Oxford 7-2700. Dr. H. R. Snow, VP-mfg. Parent, Standard Oil Co (Ind). (Merged with Pan-Am Southern Corp & Pan American Refining Corp.)*

• El Dorado, Ark 10-1
PO Box 1352; ph Union 3171. Formerly Pan-Am Southern Corp refinery.
Crude oper cap 38,000.
Prin prods—mtr gaso 19,000, avgas 600, htg oils (incl diesel) 14,000, fuel oils 1000, rfy gas liqs 400, coke 370 t/cd.
Fuel proc units—fluid cat crack (2 units) 16,000 fresh & 4000 recycle, therm crack (part of crude unit) 2700, Ultraformer 5200, Std Ind delayed coker 9000, UOP cat poly prod 450, HF alky prod 1460.
Key personnel—J. M. Brown, mgr.
Constr plans—5200 Ultraformer by Lummus, for 1957 compl; 10400 Std Ind hydrodesulf by Lummus, for 1957 compl.

• Savannah, Ga 10-2
PO Box 1881; ph 2-4196. (Formerly Mexican Petroleum Co of Georgia).*
Crude oper cap 6500.
Prin prods—mtr gaso 200, htg oils 700, fuel oils 1300, asphalt 600 t/cd.
Key personnel—W. A. Burns, mgr.

• Destrehan, La 10-3
18 mi W of New Orleans on Mississippi River; PO Box 2; ph Norco, La 2741. Formerly Pan-Am Southern Corp refinery.
Crude oper cap 35,000.
Prin prods—mtr gaso 14,000, htg oils (incl diesel) 12,000, fuel oils 1000, rfy gas liqs 500, coke 370 t/cd, asphalt 1100 t/cd.
Fuel proc units—Model IV fluid cat crack 17,000 fresh & 1000 recycle, Fluid Hydroformer 2500, Std Ind delayed coker 10,000, sulf acid alky prod 2000.
Key personnel—H. A. Heiss, mgr.

• Baltimore, Md 10-4
PO Box 1417; ph Curtis 7-0410.
Crude oper cap 9000.

American Oil Co (cont)
Prin prods—mtr gaso 300, htg oils 1000, fuel oils 2000, asphalt 1000 t/cd.
Key personnel—E. R. Grey, mgr.

• Texas City, Tex **10-5**
Box 401; ph 5-2311.
Crude oper cap 145,000.
Prin prods—mfr gaso 82,000, avgas 1400, htg oils 32,000, fuel oils 19,000, rfy gas liqs 200, asphalt 1000 t/cd.
Fuel proc units—fluid cat crack (2 units) 60,000 fresh & 1000 recycle, 3 combination units (therm crack 25,000, visbreak 23,000, therm reform 9500), Ultraformer 18,000, Std Ind hydrodesulf 19,000, UOP cat poly prod (2 units) 3200, sulf acid alky prod 8500.
Key personnel—B. F. Babin, mgr.
Constr plans—19,000 Ultraformer by Lummus, onstream '58.

• Yorktown, Va **10-6**
PO Box 578; ph Seaford 2011.
Crude oper cap 33,000.
Prin prods—mfr gaso 18,000, htg oils 10,000, fuel oils 1000, rfg gas liqs 1000, coke 600 t/cd.
Fuel proc units—Orthoflow cat crack 19,000 fresh & 8000 recycle, Ultraformer 6500, Std Ind hydrodesulf (reform feed) 6500, Std Ind hydrodesulf (other) 13,000, Std Ind delayed coker 9000, UOP cat poly unit.
Key personnel—M. C. Hopkins, mgr.
Constr plans 50 t/d Fluor gas treat and sulf recov, onstream 11-57; 23,000 asphalt crude unit planned for '58 compl.

AMERICAN PETROFINA, INC **11**
10 Rockefeller Plaza, New York, N.Y. (Formed by merger of Panhandle Oil Co into American Petrofina, Inc. Subsid, American Liberty Oil Co, bought Apr '57.)*

• Wichita Falls, Tex **11-1**
in city limits; PO Box 1191, Wichita Falls; ph 2-1151.
Crude oper cap 8000.
Prin prods—mfr gaso 3850, jet fuels 1425, htg oils 1000, fuel oils 900, rfy gas liqs 150.
Fuel proc units—UOP fluid cat crack 2500 fresh & 200 recycle, therm crack 1980 fresh & 5220 recycle, therm reform 300, UOP cat poly prod 240.
Key personnel—L. C. Brown, mgr-rfg; R. W. Jacobs, supt; N. G. Miller, asst supt.
Constr plans—3000 Platformer by Tears Engineers, onstream 8-1-57.

ANDERSON-PRICHARD OIL CORP **12**
1000 Liberty Bank Bldg, Oklahoma City, Okla; ph RE 6-5641. N. Prichard, VP-mfg; J. C. Bradley, genl supt of rfys.

• Arkansas City, Kans **12-1**
mi SE of city; ph 2300. (Formerly Kamotex Refining Co refinery).*
Crude opera cap 18,580.
Prin prods—mtr gaso 11,250, htg oils 4460, fuel oils 490, rfy gas liqs 295.
Fuel proc units—UOP fluid cat crack 7500 fresh & 3500 recycle, Winkler- Koch therm crack 3500 fresh, Platformer 5000, UOP poly prod 750.
Key personnel—R. L. Curry, plt supt; D. Conley, chf engr.
Constr plans—increase cap UOP crude unit to 25,000; comnl sched June-57; 3000 Esso Propane deasphalting unit, compl sched 8-1-57.

• Cyril, Okla **12-2**
E just outside city limits; ph 23.
Crude oper cap 10,780 oper, 220 idle.
Prin prods—mtr gaso 3826, htg oils 880, fuel oils 72, rfy gas liqs 75.
Fuel proc units—UOP fluid cat crack 5000, Winkler-Koch therm crack 5000, Catformer 1000, Unifiner 1000, UOP poly prod 200.
Key personnel—W. L. Steiner, plt supt; O. F. Bowden, chf engr.

ARIZONA REFINERIES, INC* **13**
c/o Ebasco Services, New York, NY. See Proven Oil & Refining Co & Thunderbird Corp for similar plans.

• Coolidge, Ariz—planned **13-1**
(ODM FTA approval for $12-million, issued 1954).*
Crude oper cap 15,000 planned.
Constr plans—by Ebasco.

AROMALENE, INC **14**
1840 E 29th St, Long Beach, Calif; ph Garfield 4-5560. H. W. Mangold, Pres; R. T. Hand, VP. Crude refining discontinued.

ASHLAND OIL & REFINING CO (Ky) **15**
1409 Winchester Ave, Ashland, Ky; ph East 4-1111. R. A. Whealy, coordinator of rfs & sales. Subsids, National Refining Co; Frontier Oil Refining Co; Valvoline Oil Co; Aetna Oil Co; Ashland Oil & Refining Co (Ohio); Western Reserve Refining Co.

• Catlettsburg, Ky **15-1**
3 mi S of Catlettsburg on Ky Rt 3, on Big Sandy River; mail & ph as above.
Crude oper cap 55,000.
Prin prods—mtr gaso 23,180, jet fuels 1350, htg & diesel oils 16,900, fuel oils 7200, rfy gas liqs 525, asphalt 570 t/cd.
Fuel proc units—UOP fluid cat crack 23,000 fresh & 9500 recycle; Dubbs therm crack 5500 fresh & 11,000 recycle, Sinclair-Baker cat reform 6,000, therm reform 3,000, cobalt-moly hydrotreat 9500, UOP cat poly prods 1750.
Key Personnel—G. Myers, rfy supt; H. Czeskleba, opers supt.

ASHLAND OIL REFINING CO (Ohio) **16**
Gambrianus Rd, Canton, Ohio; ph Greenwood 7-4565. Parent, Ashland Oil & Refining Co (Ky).

• Canton, Ohio **16-1**
address & ph as above.
Crude oper cap 26,200.
Prin prods—mtr gaso 11,200, jet fuels 3200, htg oils 6650, fuel oils 4400, rfy gas liqs 300.
Fuel proc units—UOP fluid cat crack 10,600 fresh & 2600 recycle, visbreak 9700, cat poly prod 985.
Key Personnel—W. N. Marx, rfy supt; M. R. Bradley, opers supt.
Constr plans—6900 cat reformer by Blaw-Knox, onstream July-57; 9600 Co-Mo desulf by Blaw-Knox, onstream July 57; 14,250 vac tower by Blaw-Knox, onstream Jan-58.

ATLANTIC REFINING CO, THE **17**
PO Box 7258, Philadelphia 1, Pa; ph PEnnypacker 5-2345.

• Philadelphia, Pa **17-1**
PO Box 8138, Philadelphia 1; ph Howard 5-2345.
Crude oper cap 157,000.
Prin prods—mtr gaso, jet fuels, htg oils, fuel oils, lube oil, rfy gas liqs, greases, waxes, asphalts.
Fuel proc units—fluid cat crack 20,000 fresh & 10,000 recycle, fluid cat crack 24,000 fresh & 6000 recycle, Catformer 12,000, poly prod 700 & 1200, alky prod 2000 & 3400.
Key personnel—D. T. Shaw, rfy mgr; J. S. Patchin, asst rfy mgr; H. V. Hume, supt-rfy dept.
Constr plans—15,000 Unifiner-Catformer by Blaw-Knox, onstream July-57.

• Port Arthur, Texas (Atreco Rfy) **17-2**
PO Box 849.
Crude oper cap 62,000.
Prin prods—mtr gaso, htg oils, fuel oils.
Fuel proc units—fluid cat crack 22,500 fresh & 6500 recycle; Catformer 7200, poly prod 150.
Key personnel—P. L. Robison, rfy mgr; B. E. Milner, genl supt; M. Mandel, supt-proc dept.
Constr plans—15,000 Unifiner-Catformer by Blaw Knox, onstream July-57.

AURORA GASOLINE CO **18**
15911 Wyomina Ave, Detroit 38, Mich; ph UN 3-5800. F. C. Moriarty, VP-mfg.

• Detroit, Mich **18-1**
12800 Northampton, Detroit 17; ph Vinewood 3-9100.
Crude oper cap 45,000.
Prin prods—mfr gaso 15,000, jet fuels 350, htg oils 13,000, fuel oils 12,000, asphalt 1700, rfy gas liqs 250, coke 100 t/d.
Fuel proc units—UOP fluid cat crack 12,500 fresh & 2000 recycle (to be increased 40% by Apr 1), Rexforming 4,600, gas oil Unifiner 8000, Fluid Coking 4600, UOP visbreak 5800, UOP poly prod 700 (to be increased 40% by May 1).
Key personnel—L. A. Curran, asst VP-mfg; P. A. Blasco, genl mgr-rfg opers; H. Murphy, opers supt; T. J. Oleszko, mgr tech serv dept; H. J. Oberding, chf engr.

• Elsie, Mich **18-2**
640 N Ovid St, Elsie; ph 25.
Crude oper cap 5850.
Prin prods—mtr gaso 1200, jet fuels 200, htg oils 1950, fuel oils 1800, cat crack chge 300.
Fuel proc unit—Platformer 1100.
Key personnel—R. Scott, supt.

• Muskegon, Mich **18-3**
2920 E Laketon Ave, Muskegon; ph 6-2186.
Crude oper cap 11,500.
Prin prods—mtr gaso 3250, htg oils 3350, fuel oils 4000, cat crack charge 600.
Fuel proc units—UOP therm crack 3350, Platformer 2100, Unifiner 750, poly prod 80.
Key personnel—R. E. McCarthy, supt; C. G. Horner, asst supt.

AVIATION FUELS INC* **19**
c/o Tears Engineers, Dallas, Tex. Reorganized version of Avtane Refining Co. A. L. Ro-Sene, VP.

• Beaumont, Texas—planned **19-**
ODM FTA approval for $24.8-million, issue 1955.
Crude oper cap 8000.

B

BANKLINE OIL CO* ..... **2(**
437 S Hill St, Los Angeles 13, Calif; ph Michigan 1251. L. L. Aubert, Pres & genl mgr.

• Bakersfield, Calif **20-1**
Rosedale Hwy (Box 286), Bakersfield; ph Fairview 4-4744. Formerly The Norwalk Co.
Crude oper cap 8000.

BAY PETROLEUM CORP, THE ..... **2(**
PO Box 957, Denver 1, Colo; ph TAbor 5-6374. C. O. Garbrecht, VP. Parent, Tennessee Gas Transmission Co.

• Denver, Colo **21-1**
mi NE of Denver on Brighton Blvd; mail & ph as above.
Crude oper cap 10,000.
Prin prods—mtr gaso 5000, jet fuels 1100, kerosine 20, htg oils 600, fuel oils 1000, rfy gas liqs 40, diesel fuel 1700.
Fuel proc units—fluid cat crack 4000 fresh & 1000 recycle, visbreak 4300, poly prod 260.
Key personnel—R. R. Rankin, rfy supt; R. J. Humbert, opers supt.
Constr plans—cat reformer.

• McPherson, Kansas (shutdown) **21-2**
partially dismantled and balance sold.

• Chalmette, La **21-3**
9 mi E of New Orleans in Chalmette; PO Box 507, Chalmette; ph Edgewood 1-1655.
Crude oper cap 23,000.
Prin prods—mtr gaso 11,500, kerosine 3700, htg oils 3500, fuel oils 1500, rfy gas liqs 900, diesel fuel 1150.
Fuel proc units—fluid cat crack 8000 fresh & 2000 recycle, Platformer 5000, poly prod 360, visbreak 10,000.
Key personnel—A. G. Pollard, rfy supt; B. C. Iglehart, opers supt.

BAY REFINING CORP **22**
1201 Second Natl Bank Bldg, Saginaw, Mich; ph Pleasant 2-2116. W. R. Stewart, VP & genl mgr. Parent, Dow Chemical Co.

• Bay City, Mich **22-1**
Prairie Rd; PO Box 166; ph Twinbrook 5-8507.
Crude oper cap 10,500.
Fuel proc units—Socony cat crack 6000, UOP poly prod 400.
Key personnel—F. Tiernan, rfy supt; L. Allen, asst supt.

BAYOU STATE OIL CORP* **23**
405 Louisiana Bank Bldg (Box 1514), Shreveport, La; ph 2-0739. P. M. Brown, Pres & genl mgr.

• Hosston, La **23-1**
Box 106.
Crude oper cap 1000 skimming.

BELL OIL & GAS CO **24**
PO Box 2007, Tulsa, Okla; ph CH 2-7191. J. P. Dyer, Secy. Subsid, Ben Franklin Refining Co.

• Grandfield, Okla **24-1**
½ mi W and ½ mi N of Grandfield (Box 118); ph Grover 9-5206.
Crude oper cap 8000.
Prin prods—mtr gaso 4000, jet fuels 900, htg oils 1300, fuel oils 1150, rfy gas liqs 50.
Fuel proc units—UOP therm crack 4000, Platformer 1800, poly prod 200, (LPG propane) 50.
Key personnel—E. S. Horner, gen mgr of rfys; R. Russell, supt.

BERRY ASPHALT CO. OF ARKANSAS **25**
Box 800, Magnolia, Ark; ph 900. A. T. Van Pelt, VP. Parent, Bird & Co, Inc.

• Stephens, Ark **25-1**
mi N of Stephens; ph 4561.
Crude oper cap 1600.
Prin prods—mtr gaso 50, jet fuels 200, htg oil 500, asphalt.
Key personnel—M. Moore, rfy supt.

• Waterloo, Ark **25-2**
ph 2181.
Crude oper cap 1000.
Prin prods—fuel oils 100, lube oil 50, asphalt.
Key personnel—M. Moore, rfy supt.

• Gary, Ind* (Johnson Oil Supply) **25-3**
Box 239, (Formerly belong to Johnson's, In Berry has long term lease made in 1953).*
Crude oper cap 6000.
Key personnel—F. Farmer, supt.

BIG HORN REFINING CO* 26
18-17 Ernest & Cranmer Bldg, Denver, Colo. Organized 1956 by Wyo, Mont & Eastern interests.

• **Lovell, Wyo** 26-1
Leased from Ohio Oil Co, ultimate purchase planned.
Crude oper cap 6500.

BIG WEST OIL CO OF MONTANA* 27
617 Hutton Bldg, Spokane 8, Wash. R. G. Hawley, Pres.

• **Kevin, Mont** 27-1
Crude oper cap 2000.

BREAUX BRIDGE OIL REFINING CO, INC* 28
PO Box 356, Breaux Bridge, La; ph 7126.

• **Anse La Butte, La** 28-1
mail as above.
Crude open oper cap 1000.

BRYSON PIPELINE & REFINING CO 29
Box 143, Bryson, Tex; ph 38.

• **Bryson, Texas** 29-1
mail & ph as above.
Crude oper cap 2000.
Prin prods—mtr gaso 800, htg oils 200, lube oil 200, greases 100.
Key personnel—R. Young, rfy mgr; N. W. Herring, rfy supt.

BYERLYTE CORP* 30
2300 W 3rd St, Cleveland 13, Ohio; ph PRospect 1-0345. D. N. Myers, Pres & genl mgr. Affil, Allby Asphalt & Refining Corp.

• **Cleveland, Ohio** 30-1
Prin prods—asphalts.

• **Heath, Ohio** 30-2
Prin prods—asphalts.

C

C & H REFINERY* 31
Lusk, Wyo.

• **Lusk, Wyo** 31-1
Crude oper cap 150 skimming.

CACTUS PETROLEUM, INC* 32
Box 396, LaBlanca, Tex; ph Amherst 2-1322. Formerly South Texas Refining Co. McBride Oil & Gas Corp, McBride Refining Co (LaBlanca, Tex), & Port Fuel Co, Inc (Port Brownsville, Tex).

• **LaBlanca, Texas**—shutdown 32-1
Box 269.
Crude oper cap (when oper) 3500.

• **Port Brownsville, Texas**—shutdown 32-2
Crude oper cap (when oper) 9500.

CALIFORNIA OIL CO, THE 33
1200 State St, Perth Amboy, NJ; ph Hillcrest 2-4200. Parent, Standard Oil Co (Calif).

• **Perth Amboy, N.J** (Rfg Div) 33-1
NE part of City; mail & ph as above.
Crude oper cap 77,000.
Prin prods—mtr gaso 25,000, avgas 1600, htg oils 26,000, fuel oils 14,000.
Fuel proc units—Houdriflow cat crack 25,000 fresh & no recycle, Platformer 11,000, visbreak 4000, Calif cat poly prod 300, Kellogg alky prod 2000.
Key personnel—R. H. Rowland, rfy mgr; E. J. Karle, genl supt; A. H. Wallchen, supt mfg div; J. H. Williams, chf engr.
Constr plans—8000 dehexanizer, onstream 1-1-58; 10,000 crude unit addition, onstream 4-1-48.

CALSTATE REFINING CO 34
2930 Cherry Ave, Long Beach 6, Calif; ph Garfield 4-8543.

• **Long Beach, Calif** 34-1
mail & ph as above.
Feedstock SR fuel oil.
Prin prods—mtr gaso 700, fuel oils 1600.
Fuel proc units—therm crack 2500 total, Hyperformer (shutdown) 1100.
Key personnel—E. G. Slack, genl mgr; C. W. Gill, opers supt.

CALUMET REFINING CO 35
13921 Mackinaw Ave, Chicago 33, Ill; ph Torrence 6-9100.

• **Burnham, Ill** 35-1
in Burnham SE edge of Chicago; mail & ph as above.
Crude oper cap 1000.
Prin prods—htg oils 130, flux or asphalt 170, lube oil 690.
Key personnel—A. M. Conrad, rfy supt; E. W. Carman, tech dir of res.

• **Princeton, La** 35-2
16 mi E of Shreveport; PO Box 1167, Shreveport; ph Haughton 2321.
Crude oper cap 900.
Prin prods—diesel fuel 125, fuel oils 25, lube oil 460, asphalt 275.
Key personnel—J. F. Harris, rfy mgr; M. Williams, rfy supt.
Constr plans—2000 b/sd crude oil dist unit, to incr asphalt prod to 360 and diesel fuel to 225, by staff & M. W. Kellogg, compl July-57.

CAMINOL CO 36
525 W 3rd St (PO Box 466), Hanford, Calif; ph Ludlow 2-0241. W. L. Marconi, Exec VP.

• **Hanford, Calif** 36-1
mail & ph as above.
Crude oper cap 6000 oper, 800 idle.
Prin prods—mtr gaso 2140, jet fuels 320, htg oils 225, fuel oils 2360, rfy gas liqs 85.
Fuel proc units—therm crack 2600 fresh & 1600 recycle, therm reform 300 fresh & 600 recycle, visbreak 2000, poly prod 150.
Key personnel—H. O. Stevenson, VP-mfg; M. V. Mueller, rfy supt; J. Leonard, plt engr.
Constr plans—1000 cat reformer for Dec-57.

CANAL REFINING CO* 37
714 Atlas Life Bldg, Tulsa 3, Okla; ph Luther 4-5291. R. E. Mockley, Pres.

• **Church Point, La** 37-1
Crude oper cap 1200.

CARTER OIL CO, THE 38
Box 801, Tulsa 2, Okla; ph CHerry 2-6101. Parent, Sandard Oil Co (NJ).

• **Billings, Mont** 38-1
3 mi E of Billings; Box 1163 ph 9-4511.
Crude oper cap 24,000.
Prin prods—mtr gaso 8700, jet fuels 1750, htg oils & dist fuels 6750, fuel oil 2090, asphalts & road oils 1530, Fluid coke 270 t/cd.
Fuel proc units—fluid cat crack 12,000 fresh & 13,000 recycle, Powerformer 2500, Hydrofiner 6900, Fluid Coker 3800 fresh & 500 recycle; non-selective poly prod 975.
Key personnel—I. J. Staid, mgr of mfg; R. W. Burns, asst mgr of mfg; G. W. Wallis, chf engr.

CENTURY OIL CO 39
2345 E 28th St, Long Beach 6, Calif; ph Garfield 4-1663. C. S. Cox, VP.

• **Signal Hill, Calif** 39-1
corner 28th & Junipero Sts, Signal Hill; mail & ph as above.
Crude oper cap 5000.
Prin prods—mtr gaso 1450, htg oils 600, fuel oils 3150.
Key personnel—C. S. Cox, Vp (rfy supt); F. Flowers, asst supt.

CENTURY REFINING CO, INC* 40
Box 459, Garden City, Kans; ph 5522. M. L. Brown, Pres. Was Shallow Water Refining Co.

• **Shallow Water, Kans** 40-1
Crude oper cap 2000 oper, 2000 idle.

CHAMPLIN OIL & REFINING CO 41
PO Box 9365, Ft Worth, Tex; ph Pershing 8-7391. L. A. Whitney, VP-mfg. Formerly The Chicago Corp.

• **Enid, Okla** 41-1
3 mi NE of Enid center on 26th St; PO Box 552 Enid; ph Adams 4-2600.
Crude oper cap 29,500.
Prin prods—mtr gaso, jet fuels, htg oils, fuel oils, lube oil, rfy gas liqs, waxes, asphalt.
Fuel proc units—Orthoflow cat crack 9000 fresh & 4000 recycle, Platformer 5000, UOP cat poly prods 900 of 2 RVP.
Key personnel—E. M. Beebe, rfy mgr; E. Jones, chf oper; V. Slusher, chf engr.
Constr plans—1400 Phillips HF alky planned for Apr-58 compl.

CHANUTE REFINING CO., THE* 42
Box 431, Chanute, Kans; ph 245. N. Strauss, Pres.

• **Chanute, Kans** 42-1
Crude oper cap 1500.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

CHEMOIL CORP 43
719 Carondelet Bldg, New Orleans 12, La; ph Express 3374. J. R. Tusson, Pres.

• **Louisiana**—planned 43-1
between New Orleans & Baton Rouge.
Crude oper cap 30,000 planned.
Prin prods—mtr gaso 20,000, avgas 2000, htg oils 6500, fuel oils 1300, rfy gas liqs 650, coke 450 t/cd.
Fuel proc units—cat crack, cat reform, cat poly, cat alky, coking, treating.

CHICAGO CORP*
now Champlin Oil & Refining Co by merger with wholly owned subsidiary, Champlin Refining Co, in 1957.

CIT-CON OIL CORP 44
PO Box 1578, Lake Charles, La; ph HEmlock 6-4361. L. Haugen, VP. Parents, Cities Service Co & Continental Oil Co.

• **Lake Charles, La** 44-1
13 mi SW of Lake Charles; mail & ph as above.
Prin prods—lube oil 9000, waxes 14-million lb/mo.
Proc units—Duo-Sol 10,000, Furfural 11,800, MEK dewax 11,800.
Key personnel—L. Haugen, VP & gen mgr; W. M. Cocke, asst genl mgr; E. G. Hendrickson, chf engr.
Constr plans—modif of present equip by Tears Engrs & Hydrocarbon Constr Co, compl 1-1-58.

CITIES SERVICE CO
70 Pine St, New York 5, NY; ph HAnover 2-1600. J. W. Griswold, staff exec, Cities Service Petroleum, Inc, above address. Subsids, Cities Service Oil Co (Del), Cities Service Refining Corp, Cities Oil Co (Pa). Part owner, with Continental Oil Co, of Cit-Con Oil Corp.

CITIES SERVICES OIL CO (DEL) 45
Bartlesville, Okla; Parent Cities Service Co.

• **East Chicago, Ind** 45-1
4900 Cline Ave (Box 718), East Chicago; ph 6560.
Crude oper cap 37,837 (on strike 105 days during 1956).
Prin prods—mtr gaso 24,708, htg oils 10,749, fuel oils 2655, rfy gas liqus 2212, coke 1527.
Fuel proc units—Kellogg fluid cat crack 21,600 fresh & 8400 recycle, Kellogg Fluid Hydroform 13,000, Shell vapor-phase isom 1800, Kellogg delayed coking 15,000, sulf acid (Jersey) alky prod 2560.
Key personnel—. C. Soudriette, plt mgr; J. A. Witherspoon, asst mgr opers; I. W. Scroggin, asst mgr-tech serv.
Constr plans—74,000 crude-light ends unit by Procon, onstream 10-1-57.

• **Ponca City, Okla** 45-2
PO Box 1300, Ponca City; ph Rogers 5-3346.
Crude oper cap 22,855.
Prin prods—mtr gaso 17,636, htg oils 6080, fuel oils 1300, compounded oils 317, rfy gas liqs 838, greases 3090 lb/cd, coke 602.
Fuel proc units—Kellogg cat crack 10,080 fresh & 3920 recycle, Doherty therm crack 800, Doherty therm reform 2200, Rexformer 6000, Dubbs coking 1500.
Key personnel—H. W. Torgeson, plt mgr; L. B. Brannin, asst mgr opers; C. W. Rohler, asst mgr-tech serv.
Constr plans—10,000 UOP crude unit expansion by Procon, onstream 5-1-57.

CITIES SERVICE OIL CO (PA) 46
70 Pine St, New York 5, NY. Parent, Cities Service Co.

• **Linden, NJ** 46-1
Ft of Wood Ave, 3 mi SE of US Hwy & Wood Ave; PO Box 228, Linden; ph Hunter 6-0500.
Crude oper cap 15,000.
Prin prod—asphalt 7500.
Key personnel—A. Kirkpatrick, supt.

CITIES SERVICE REFINING CORP 47
716 Hodges St, Lake Charles, La; ph HEmlock 3-4611. L. D. Mann, Pres & genl mgr; G. L. Mateer, VP & asst genl mgr. Parent, Cities Service Co.

• **Lake Charles, La** 47-1
3½ mi S of Hwy between Lake Charles & Sulphur, La, on W bank of Calcasieu River; mail as above; ph HEmlock 3-5211.
Crude oper cap 185,000.
Prin prods—mtr gaso 76,500, avgas 24,000, (mtr gaso & kero include 19,400 bbl purchased light ends), jet fuels 7000, kero 20,000, htg oils 43,000, fuel oils 9500, lube oil 650, rfy gas liqs 1500.
Fuel proc units—Kellogg fluid cat crack (3 units) 85,000 fresh & 35,000 recycle, Kellogg Fluid Hydroform 15,000, Kellogg comb therm reform-crack unit (used primarily for

Cities Service Refining Corp (cont)
visbreaking) 14,000 fresh & 6000 recycle, Kellogg sulf acid alky prod 15,000.
Key personnel—H. R. Smith, genl supt; A. A. Forter, proc supt; R. A. Given, tech supt; C. W. Stokes, genl suprg engr.
Constr plans—4500 Butane isom; cat crack additions for compl May-57; alky, hydroform and treat plant additions, for compl Apr-57.

CLARK OIL & REFINING CORP 48
8530 W National Ave, Milwaukee 14, Wis; ph GReenfield 6-3720. J. A. Crawford, VP.

• **Blue Island, Ill** 48-1
131st St & Kedzie Ave; Box 297, Blue Island; ph FUlton 5-5000.
Crude oper cap 23,000.
Prin prods—mtr gaso 11,400, htg oils 6600, fuel oils 3700, rfy gas liqs 200.
Fuel proc units—Houdriflow cat crack 7000 fresh & 500 recycle, therm gas oil crack 1500 fresh & 2000 recycle, Platformer 6000, UOP poly prod 700.
Key personnel—J. A. Crawford, VP & rfg mgr; W. J. Watson, rfy supt; R. H. Bruggink, tech dir; K. Forry, asst supt.
Constr plans—13,500 vac unit by Morrison Constr Co, due onstream 9-57; 12,500 UOP fluid cracker by Procon, Inc, due onstream 4-58; 1500 UOP Alky due onstream 4-58.

• **Marrero, La** 48-2
Box 517, Marrero; ph Fillmore 1-2206.
Crude oper cap 6500.
Prin prods—varies.
Fuel proc units—therm crack 3000 fresh, poly prod 125.
Key personnel—G. A. Birdsall, supt & engr; G. B. Campbell, asst supt.

COL-TEX REFINING CO 49
Colorado City, Tex; ph Randolph 8-2411. Parent, Cosden Petroleum Corp. (Formerly owned by Anderson-Pritchard Oil Corp & Standard Oil Co of Calif.)*

• **Colorado City, Tex** 49-1
mi W of Colorado City on US Hwy 80; ph & mail as above.
Crude oper cap 12,000.
Prin prods—mtr gaso 3500, jet fuels 2500, htg oils 1350, fuel oils 550, asphalt 510 t/cd, frac oil 700.
Fuel proc units—single-coil therm crack 4000 fresh & 13,000 recycle, Platformer 1500, UOP Unifiner 1800, Calif phos acid poly prod 200.
Key personnel—C. F. Wakefield, supt; T. T. Crawford, res engr.

COMMERCE OIL REFINING CORP 50
515 Madison Ave, New York 22, NY; ph PLaza 9-2345. H. M. Geller, Pres. (Affiliate of Commerce Oil Corp, Warren, Pa.)*

• **Jamestown, RI**—building 50-1
Crude oper cap 40,000.
Prin prods—mtr gaso 24,000, heating oils 9000, fuel oils 1000, rfy gas liqs 1800, coke 528 t/d.
Fuel proc units—UOP cat crack, Platformer, UOP Unifiner, Penex isom, Lummus visbreak, UOP poly, sulf alky.

CONTINENTAL OIL CO 51
PO Box 2197, Houston, Tex; ph Capital 5-15-11. Also part owner, with Cities Service Co, of Cit-Con Oil Corp. (See Sherwood Refining Co.)*

• **Denver, Colo** 51-1
5 mi NE of downtown Denver, on Brighton Blvd; mail 1755 Glenarm Pl, Denver 2, Colo; ph ATlas 8-2651.
Crude oper cap 11,130.
Prin prods—mtr gaso 6670, htg oils 3036, fuel oils 1120, rfy gas liqs 231.
Fuel proc units—TCC cat crack 4120 fresh & 2540 recycle, 2-coil therm crack (incl reforming 940, and visbreak 1387) 7270 total & 2913 fresh, UOP cat poly prod 440.
Key personnel—C. Morgan, rfy supt; R. W. Broadhurst, asst supt; R. M. Haynes, res engr.

• **Westlake, La** (Lake Charles rfy) 51-2
mi W of Westlake on Hwy 99; PO Box 37, Westlake; ph HEmlock 6-9561.
Crude oper cap 52,000.
Prin prods—mtr gaso 20,400, avgas 4500, htg oils 19,800, fuel oils 4000, rfy gas liqs 3000.
Fuel proc units—TCC cat crack 17,000 fresh & 3000 recycle; 3 furnace coils in one unit consisting of therm crack 6000, therm reform 2000 & visbreak 2000; Platformer 5000; UOP poly prod 550; sulf acid alky prod 3000.
Key personnel—J. M. Jones, rfy mgr; K. S. Andrea, rfy supt; M. H. Clark, asst supt; E. K. Dewey, res engr.
Constr plans—10,000 delayed coker by Fluor, onstream 2-58.

• **Billings, Mont** 51-3
23rd & 4th Ave S; PO Box 2523, Billings; ph 9-4561.
Crude oper cap 8827.
Prin prods—mtr gaso 4787, htg oils 2176, fuel oils 1786, rfy gas liqs 79.
Fuel proc units—UOP fluid cat crack 3620 fresh & 4300 recycle, Conoco cat reform 1650, Unifiner (incl naphtha) 4800, UOP cat poly prod 386.
Key personnel—J. A. Ramsey, rfy supt; H. G. Owen, asst supt; J. L. Bruce, res engr.

• **Artesia, NM** 51-4
E edge of Artesia; PO Box 158, Artesia; ph SHerwood 6-3505.
Crude oper cap 3900.
Prin prods—mtr gaso 2000, heating oils 700, fuel oils 600.
Fuel proc units—Houdriformer 1200, visbreak 1500, therm desulf 1600.
Key personnel—E. E. Gillespie, rfy supt; W. W. Lucas, res engr.

• **Farmington, NM**—shutdown 51-5
SE edge of Farmington; PO Box 548, Farmington; ph DA 5-2461. To be dismantled.
Crude oper cap 434.
Prin prods—mtr gaso 410, fuel oils 82.
Key personnel—H. H. Kinnaird, rfy supt.

• **Ponca City, Okla** 51-6
Adjacent to city limits; Box 1267, Ponca City; ph ROgers 5-6661.
Crude oper cap 58,000.
Prin prods—mtr gaso 25,500, avgas 1830, jet fuels 5000, htg oils 16,800, fuel oils 2200, lube oil 2250, rfy gas liqs 870, greases 43,700 lb/cd, waxes 40 t/cd, coke 500 t/cd.
Fuel proc units—TCC cat crack (2 units of 11,000 & one of 8000) 17,500 fresh & 12,500 recycle, Cross therm crack 5500 fresh & 13,500 recycle, Platformer 4900, Cross therm reform 3000, delayed coker 12,500 fresh & 1000 recycle, UOP poly prod 750, HF alky prod 3875.
Key personnel—C. D. Hull, rfy mgr; L. H. Barnes, rfy supt; F. W. Willoughby, asst supt.
Constr plans—11,000 cat reform by Kellogg, onstream 7-1-57; 16,000 naphtha desulf by Kellogg, onstream 7-1-57.

• **Wichita Falls, Tex** 51-7
N edge of Wichita Falls on Hwy 277; PO Box 750, Wichita Falls; ph 3-8181.
Crude oper cap 8000.
Prin prods—mtr gaso 5500, htg oils 900, fuel oils 1500, rfy gas liqs 700.
Fuel proc units—comb unit (9000 crude skim, 4000 therm crack, 6000 therm reform), therm & cat poly prod 1500, casinghead stabilization 700.
Key personnel—J. P. Markey, rfy supt; N. Newton, asst supt; D. S. Jay, res engr.

• **Glenrock, Wyo***—shutdown 51-8
to be dismantled.

COOPERATIVE REFINERY ASSOCIATION 52
Box 7305, Kansas City 16, Mo; ph GLadstone 3-1400. R. D. McCrum, Dir of Rfg Parent, Consumers Cooperative Association.

• **Coffeyville, Kans** 52-1
N, outside city limits; Box 570, Coffeyville.
Crude oper cap 24,000.
Prin prods—mtr gaso approx 12,000, htg oils approx 7200, lube oil approx 1500, asphalt 200 t/d, variable amounts of jet fuels, fuel oils, greases, waxes and coke.
Fuel proc units—fluid cat crack 9000 fresh, Platformer 4250, Unifiner 3000, delayed coker 8000, UOP poly prod 650.
Key personnel—G. H. Kinnick, plt supt; R. L. Vawter, asst supt; J. F. Anderson, res engr.
Constr plans—alky unit.

• **Phillipsburg, Kans** 52-2
N, outside city limits.
Crude oper cap 10,000.
Prin prods—mtr gaso approx 5000, htg oils approx 2500, asphalt 250 t/d, fuel oil varies.
Fuel proc units—fluid cat crack 4200 fresh, UOP poly prod 400.
Key personnel—D. F. Ditto, plt supt; W. C. Seidel, asst supt; W. R. Ketterman, res engr.
Constr plans—2500 Platformer, '58 compl; 3500 UOP Unifiner, '58 compl.

• **Scottsbluff, Neb** 52-3
S side in city limits; Box 311, Scottsbluff.
Crude oper cap 2200.
Prin prods—mtr gaso approx 1100, htg oils approx 550, fuel oils vary.
Fuel proc units—UOP therm crack 1000 fresh, Platformer 650.
Key personnel—C. W. Glasby, plt supt; D. G. Lowder, asst supt.

CORPUS CHRISTI REFINING CO* 53
663 Gulf Bldg, Houston, Tex. W. E. Davis, Jr, Exec VP. Owned 35% by Farmington Funding Corp, Colorado Springs, Colo.

• **Corpus Christi, Texas** 53-
Shell Rd & McBride Lane (Box 4258, We
End Sta); ph Tulip 4-0305.
Crude oper cap 7000 skimming.

• **Palestine, Texas**—idle 53-
Crude oper cap (when oper) 3500.

COSDEN PETROLEUM CORP 5
Box 1311, Big Spring, Tex; ph Amherst 4-466
D. M. Krausse, VP-mfg. Subsid, Col-Tex Refin
ing Co.

• **Abilene, Texas** (Onyx Rfy) 54-
10 mi N of Abilene on US Hwys 83 & 277
Box H, Abilene; ph OR 4-6211.
Crude oper cap 7000.
Prin prods—mtr gaso 3400 jet fuels 800
htg oils 1200, fuel oils 1000, frac oil 210.
Fuel proc units—3-coil therm crack 2800
fresh & 7800 recycle, Platformer 750, UOP
phos acid poly prod 150.
Key personnel—W. F. Manz, supt; W.
Vaughn, asst supt.

• **Big Spring, Texas** 54-2
3½ mi E of Big Spring on US Hwy 80; mail &
ph as above.
Crude oper cap 30,000.
Prin prods—mtr gaso 14,500, avgas 4000,
jet fuels 3000, htg oils 2500, fuel oils 2500,
rfy gas liqs 1000, asphalt 700 t/cd, frac oil
2000.
Fuel proc units—UOP fluid cat crack 13,500
fresh & 1500 recycle, Dubbs 2-coil therm crack
9000 fresh & 25,000 recycle, Platformer 4000,
Rexformer 3900 fresh & 1600 recycle, Unifiner
2100, UOP phos acid poly prod 900, UOP HF
alky prod 3500.
Key personnel—G. Grimes, rfy supt; E. W.
Richardson, asst supt; E. B. McCormick, chf
engr.

COTTON VALLEY SOLVENTS, INC 55
PO Box 97, Cotton Valley, La; ph #7. J. Coast,
Pres.

• **Cotton Valley, La** 55-1
3 mi S of Cotton Valley on Hwy 7; mail & ph
as above.
Oper cap, crude plus gas liquid feed, 4500.
Prin prods (specialties)—mtr gaso 1125, jet
fuels 675, htg oils 755, LPG 315, resid 505,
naphtha 1125.
Key personnel—J. A. Wreyford, plt supt.

CRACKER ASPHALT CORP 56
PO Box 276, Douglasville, Ga; ph 2343-2444.
Dr. C. B. F. Young, Pres.

• **Douglasville, Ga** 56-1
mi E of Douglasville on Hwy 78; mail & ph as
above.
Crude cap—oper 1000, idle 500.
Prin prods—htg oils, fuel oils; asphalt 170
t/d.
Key personnel—J. J. Pope, genl mgr; E. D.
Edgeworth, plt supt; W. L. Hall, asst plt supt.

CROOK COUNTY REFINERY* 57
Sundance, Wyo. P. Policky, Pres & owner.

• **Sundance, Wyo** 57-1
Crude oper cap 125 skimming.

CROSS, HENRY H, CO* 58
122 S Michigan Ave, Chicago 3, Ill; ph Wabash
2-8728. G. F. Fox, Pres. Subsids, H. H. Cross
Co (Ark), H. H. Cross Co (Ill).

• **Smackover, Ark** (Cross Co—Ark) 58-1
Drawer AA, Smackover.
Crude oper cap 3200 oper, 2800 idle.

• **Colmar, Ill** (Cross Co—Ill) 58-2
Crude oper cap 1000 skimming.

CROWN CENTRAL PETROLEUM CORP 59
PO Box 1168, Baltimore, Md.; ph Lexington
9-7400. K. W. Shimeall, VP-Southwest opers;
414 Bank of the Southwest Bldg, Houston 2,
Tex.

• **Pasadena, Tex** 59-1
PO Box 1759, Houston 1, Tex; ph GReenwood 2-2461.
Crude oper cap 36,000.
Fuel proc units—TCC cat crack 16,000
fresh & 4000 recycle, HMVS therm crack
7500, Houdriformer 5000, Houdry guard case
hydropretreat 5000, cat poly prod 900 (shut-
down), HF alky prod 3300 (shutdown).
Key personnel—R. T. Colquette, VP-rfg; R.
S. Meyers, rfy supt; H. E. Fischer, chf engr.

CRYSTAL REFINING CO 60
8720 Livernois St, Detroit 4, Mich. M. H.
Fleischman, VP.

• **Carson City, Mich** 60-1
ph 2201.
Crude oper cap 3000 oper, 3200 idle.

Prin prods—mtr gaso 750, htg oils 1200, jet oils 1050.
Key personnel—E. G. Guy, rfy mgr; T. Miller, rfy supt.
Constr plans—1000 naphtha dist by Litwin Engrg Co.

D

D-X SUNRAY OIL CO **61**
PO Box 381, Tulsa, Okla; ph DI 3-3101. H. A. Brown, VP-rfg. Parent, Sunray Mid-Continent Oil Co.

• **Allen, Okla** (shutdown) **61-1**
refinery being dismantled.

• **Duncan, Okla** **61-2**
5 mi S of Duncan, on Hwy 81; PO Box 831, Duncan.
Crude oper cap 37,800 oper, 5200 idle.
Prin prods—mtr gaso 22,260, avgas 3000, jet fuel 3000, htg oils 10,360, fuel oils 2210, LPG 820, coke 330 t/d.
Fuel proc units—UOP fluid cat crack 19,000 fresh & 2500 recycle, Platformer 6000, Lummus delayed coker 9000, (operated by Ucan Products Co).* UOP cat poly prod 550 (incl 370 tetramer), UOP HF alky prod 2840 (incl 120 hvy alky).
Key personnel—R. L. Johnson, rfy mgr; R. C. Underwood, asst rfy mgr; J. H. Eppard, chf proc engr.
Constr plans—6000 UOP Unifiner by Treco, onstream 1958; company revamping alky plant, compl 1958.

• **Tulsa, Okla** **61-3**
17th & Union (PO Box 381) Tulsa; ph DI 3-3101.
Crude oper cap 68,500 oper, 4500 idle.
Prin prods—mtr gaso 38,150, avgas 1960, jet fuels 1705, htg oils 16,660, fuel oils 1080, lubes 5880, LPG 720, waxes 975, coke 215 t/d, asphalt 210 t/d.
Fuel proc units—Kellogg fluid cat crack 25,500 fresh & 6400 recycle, Catformer (UOP catalyst) 7500, Kellogg delayed coker 7160 fresh & 340 recycle, Kellogg cat poly prod 1730, Kellogg H_2SO_4 alky prod 2260 (incl 260 heavy alky).
Key personnel—E. M. Dons, rfy mgr; N. B. York, asst rfy mgr; P. M. Reynolds, mgr opers & engr.
Constr plans—2500 UOP HF alky by Treco, for compl Jan-58; 12,000 Platformer by Treco, for compl Jan-58; 20,000 UOP Unifiner by Treco, for compl Jan-58; 2000 UOP Butane isom by Treco, for compl Jan-58; revamp cat cracker gas conc by Procon, for compl Apr-57; revamp IPA solv dewax plt to add 900 cap, by staff for compl Apr-57.

DALLAWAX CO **62**
PO Box 2019, Tyler, Tex; ph 2-7304.

• **Tyler, Texas**—idle **62-1**
1½ mi W of Hwy 259, 2 mi N of Kilgore, Tex; mail and ph as above.
crude oper cap 500 idle.
Prin prods—waxes 15 t/cd.
Key personnel—I. Roosth, rfy mgr; O. B. Rutherford, rfy supt.

DANAHO REFINING CO **63**
3402 Kirby Dr, Houston 6, Tex; ph Jackson 3-2575. G. T. Granger, VP.

• **Pettus, Texas** **63-1**
N line of city; ph 67.
Crude oper cap 5000.
Prin prods—mtr gaso 3400 or 1700, jet fuels 900, htg oils 950 or 750, fuel oils 500, rfy gas liqs 71.
Fuel proc units—UOP therm crack 1000 (900 fresh), Platformer 1000, UOP poly prod 100.
Key personnel—J. F. Thomson, supt.

DELHI-TAYLOR OIL CORP **64**
Corrigan Tower, Dallas, Tex; ph RIverside 8-5511. F. P. Sewell, VP-mfg & sales. (Formed in 1955 by merger of Delhi Oil Corp and Taylor Oil & Gas Corp.)*

• **Corpus Christi, Texas** **64-1**
Poth Lane (PO Box 40671), Corpus Christi; ph TU 4-4831.
Crude oper cap 32,000 oper, 8000 idle.
Prin prods—mtr gaso 15,500, jet fuels 500, htg oils 17,000, fuel oils 2500, rfy gas liqs 1000.
Fuel proc units—TCC cat crack 9600 fresh & 1400 recycle, Platformer 5500, visbreak 2400 fresh & 400 recycle, UOP cat poly 550.
Key personnel—F. A. Reneau, plt supt; J. J. Maurer, rfy engr.
Constr plans—10,500 Unifiner-Platfomer by Treco, onstream 5-15-57.

• **Port Isabel, Texas** (Delhi-Taylor & Mayfair Rfy) **64-2**
Reservoir Addition (Box 248) Port Isabel; ph WH 3-2651.
Crude oper cap 10,000 oper, 5000 idle.
Prin prods—mtr gaso 4400, htg oils 5200, fuel oils 1200, rfy gas liqs 200.
Fuel proc unit—Platformer 4500.
Key personnel—J. V. Trump, plt supt; H. B. Fessler, plt engr.
Constr plans—Dehexanizer, by staff.

DELROC REFINERIES, INC* **65**
2404 San Jacinto, Houston, Tex; ph Capitol 2-6309. R. C. Jackson, Pres.

• **Fairbanks, Texas**—shutdown **65-1**

DELTA REFINING CO* **66**
Box 3097, Memphis, Tenn. F. V. Heinkel, Pres.

• **Memphis, Tenn** **66-1**
mail as above.
Crude oper cap 6000.

DERBY REFINING CO **67**
420 W Douglas (Box 1030), Wichita 1, Kans; ph AMherst 5-1661. Parent, Colorado Oil & Gas Corp.

• **Wichita, Kans** **67-1**
1100 E 21st St, Wichita; mail & ph as above.
Crude oper cap 20,000.
Prin prods—mtr gaso 8980, jet fuels 2380, htg oils 5800, rfy gas liqs 150, asphalt 2000.
Fuel proc units—TCC cat crack 7500 fresh & 3200 recycle, Dubbs therm crack 3000 fresh & 7000 recycle, Ultraformer 2500, hydrodesulf 4000, poly prod 600.
Key personnel—F. W. McCurry, VP (rfy mgr & tech dept mgr); E. R. Jones, supt; Kersey, proc engr.

DEWESE OIL REFINERY* **68**
Weston, Ohio; ph 3913. H. Dewese, owner.

• **Weston, Ohio** **68-1**
mail and ph as above.
Oper cap 1500 (crude skimming & re-refining lube oil).

DIAMOND ASPHALT CO* **69**
Chinook, Mont.

• **Chinook, Mont** **69-1**
Crude oper cap 1500.

DOUGLAS OIL CO OF CALIF **70**
8622 E Compton Blvd, Paramount, Calif; Metcalf 3-1101. J. L. Doegey, VP-rfg.

• **Harpertown, Calif** **70-1**
Panama Lane and Weedpatch Hwy, Harpertown; PO Box 1391, Bakersfield; ph FUlton 3-0761.
Crule oper cap 7350.
Prin prods—mtr gaso 4100, jet fuels 400, htg oils 1100, fuel oils 3700.
Fuel proc units—Dubbs therm crack 4600, Platformer 2000.
Key personnel—A. C. Wynn, supt; J. D. King, asst supt.
Constr plans—1300 Union Unifiner by Macco Corp, onstream June-57; incr crude cap 12,000, compl Dec-57.

• **Paramount, Calif** **70-2**
8731 E Compton Blvd, Paramount; PO Box 697, Paramount; ph MEtcalf 3-1101.
Crude oper cap 7000.
Prin prods—jet fuels 950, htg oils 2050, asphalt 700 t/cd.
Key personnel—C. R. Campbell, rfy supt; G. Farquhar, asst supt; J. Price, asst supt.

• **Santa Maria, Calif** **70-3**
1660 Sinton Rd, Santa Maria (PO Box 871); ph WAlnut 5-2623.
Crude oper cap 2500.
Prin prods—jet fuels 100, htg oils 600, asphalt 300 t/cd.
Key personnel—J. Vaughn, rfy supt; D. Johnson, asst supt.

• **Santa Maria, Calif**—idle **70-4**
leased from western Asphalt & Refining Co.
Crude oper cap (when oper) 1500.

DUPO REFINING CO, INC* **71**
Dupo, Ill.

• **Dupo, Ill**—shutdown **71-1**
Crude oper cap (when oper) 1000.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

E

EASTERN STATES PETROLEUM CO, INC **72**
PO Box 5008, Houston 12, Tex; ph WA 3-1651.

• **Houston, Texas** (Plts 1 & 2) **72-1**
8939 Manchester Ave; mail & ph as above.
Crude oper cap 65,000.
Fuel proc units—cat crack 18,000 fresh & 1500 recycle; Platformer 8000, hydrotreat (reform feed) 9500 hydrotreat (other) 14,000, visbreak 18,000, poly prod 800, alky prod 3100.
Key personnel—H. M. Martin, mgr-rfg; W. P. Svec, mgr-opers; E. S. Perkins, chf engr.

ECONOMY ASPHALT CO* **73**
112 W Jefferson Blvd, Los Angeles 7, Calif. C. G. Scharf, Pres.

• **Oxnard, Calif**—shutdown **73-1**
Crude oper cap (when oper) 2000.

EDDY REFINING CO **74**
PO Box 185, Houston 1, Tex; ph WAlnut 8-3281. D. E. Farnsworth, Secy Treas (genl mgr.

• **Houston, Tex** **74-1**
7401 Manchester in Houston; mail as above; ph WAlnut 6-3016.
Crude oper cap 2000.
Prin prods—mtr gaso 1500, htg oil 400, fuel oils 100.
Key personnel—D. E. Farnsworth, genl mgr; C. L. Mullinax, supt/VP.

EDGINGTON OIL REFINERIES, INC* **75**
2400 E Artesia Blvd, Long Beach 5, Calif; ph Garfield 3-1465 & Nevada 6-2121. R. Edgington, Pres.

• **Long Beach, Calif** **75-1**
Crude oper cap 7000.

• **Oxnard, Calif** **75-2**
117 Deodar Ave, Oxnard; ph Hunter 3-8017.
Crude oper cap 2500.

EL DORADO REFINING CO, THE **76**
Box 551, El Dorado, Kans; ph 901. Parent, Atlas Corp, Tulsa, Okla.

• **El Dorado, Kans** **76-1**
mi N of El Dorado on N Topeka St; mail & ph as above.
Crude oper cap 17,000.
Prin prods—mtr gaso 7000, jet fuels 1900, htg oils 5000, fuel oils 600, rfy gas liqs 125, asphalt 385 t/cd.
Fuel proc units—UOP fluid cat crack 6500 fresh & 5500 recycle, Platformer 2500, UOP poly prod 420.
Key personnel—Harold J. Datin, rfy supt; K. M. Suiter, asst rfy supt.

EL PASO NATURAL GAS PRODUCTS CO **77**
PO Box 1161, El Paso, Tex; ph 3-9561. C. E. McNutt, VP & opers mgr.

• **Bloomfield, NM** **77-1**
mi N of Hwy 44, 2 mi N of Bloomfield; PO Box 25, Grants, NM; ph Atwater 7-3220. Formerly Malco Products, Inc, refinery.
Crude oper cap 500.
Prin prods—mtr gaso 450, htg oils 50.
Key personnel—J. Montgomery, rfy supt.

• **Brickland, NM** **77-2**
4 mi W of El Paso, Tex, 1½ mi S of Hwy 80 on NM Hwy 273; mail & phone as above. Formerly McNutt Oil & Refining Co refinery.
Crude oper cap 4000.
Prin prods—mtr gaso 3000, jet fuels 1080, htg oils 210, fuel oils 630.
Fuel proc units—Dubbs therm crack 1600, Platformer 600, UOP cat poly prod 40.
Key personnel—J. T. McNutt, mgr of South Div; J. P. Watson rfy supt; G. Baker, asst supt; T. M. McLeod, asst supt.

• **Gallup, NM**—building (Ciniza Rfy) **77-3**
Crude oper cap 6500.
Fuel proc units—crude, vacuum, fluid cat crack, Platformer, HF alky.

• **Grants, NM** (Prewitt Rfy) **77-4**
18 mi W of Grants, on US Hwy 66; PO Box 13, Grants; ph Federal 4-6171. Formerly Malco Refineries, Inc, refinery.
Crude oper cap 4000.
Prin prods—mtr gaso 2720, htg oils 800, fuel oils 590.
Fuel proc units—Dubbs therm crack 2000 fresh & 3800 recycle, Platformer 750, UOP cat poly prod 48.
Key personnel—R. Rider, mgr of North Div; H. B. Chambers, rfy supt; S. Yeats, asst supt; O. Harris, asst supt.

ELK REFINING CO **78**
Box 1033, Charleston 24, W Va; ph Dickens 2-8161. F. G. Bannerot, Jr, Pres. (Parent, South Penn Oil Co.)*

• **Falling Rock, W. Va** **78-1**
16 mi NE of Charleston on US Hwy 119 & Elk River; mail as above; ph WOodland 5-3388.
Crude oper cap 5000.

Elk Refining Co (cont)
Prin prods—mtr gaso 1700, htg oils 840, fuel oils 250, lube oil 1000, wax 12½ t/cd.
Fuel proc units—Dubbs therm crack 1080 total, Platformer 1250, Unifiner 400, UOP poly prod 50.
Key personnel—P. W. Emery, genl rfy supt; W. D. Cleavenger, asst supt.

EMPIRE PETROLEUM CO* 79
Box 9006, Denver 16, Colo; ph Atlas 8-0761. E. M. Stone, Pres.

• **Denver, Colo** 79-1
Crude opr cap 5000 oper, 2000 idle.

• **Sheboygan, Wisc** 79-2
Box 651, Sheboygan. Was Wisconsin Oil Refining Co, Inc.
Crude oper cap 7500.

EMPIRE STATE OIL CO* 80
242 Amoretti St, (Box 871), Thermopolis, Wyo; ph 48. J. S. Herrin, Pres.

• **Thermopolis, Wyo** 80-1
Crude oper cap 5000 skimming.

ENVOY PETROLEUM CO 81
1601 E Spring St, Long Beach 6, Calif; ph Garfield 4-8127. A. M. Lockhart, Pres.

• **Long Beach, Calif** 81-1
address & ph as above.
Crude oper cap 3500.
Prin prod—asphalt 325 t/cd.
Key personnel—P. H. Banks, rfy mgr; W. Georgeson, rfy supt.

ESSO STANDARD OIL CO 82
15 W 51st St, New York 19, NY; ph PLaza 7-3000. Parent, Standard Oil Co. of New Jersey.

• **Baton Rouge, La** 82-1
Crude oper cap 308,000 oper, 32,000 idle.
Prin prods—mtr gaso 116,800, avgas 16,100, jet fuel 11,200, htg oil 30,900, fuel oil 24,600, rfy gas liqs 5000, grease 27,335,000 lb/yr, wax 41,900,000 lb/yr, asphalt, 5,900.

• **Baltimore, Md** 82-2
Crude oper cap 57,500.
Prin prods—mtr gaso 22,700, alkylate 1300, jet fuel 600, htg oils 14,500, fuel oils 4000, rfy gas liqs 1000, grease 15,890,000 lb/yr, asphalt 4300, coke.
Fuel proc units—cat crack 34,000 fresh & 20,700 recycle, therm crack 8100 fresh, cat reform 2700, Fluid Coker.

• **Everett, Mass** 82-3
Crude oper cap 45,000.
Prin prods—mtr gaso 14,500, htg oils 11,000, fuel oils 4200, rfy gas liqs 400, asphalt 6300.
Fuel proc units—cat cracking, therm crack, visbreak.

• **Bayonne, NJ** 82-4
Crude oper cap 25,000.
Prin prods—htg oils 3600, fuel oils 300, lube oils 300, waxes 107,500 long t/yr, asphalt 5000.

• **Linden, NJ** (Bayway Rfy) 82-5
Crude oper cap 145,000.
Prin prods—mtr gaso 65,700, jet fuel 800, htg oils 34,500, fuel oils 5000, rfy gas liqs 4400.
Fuel proc units—cat crack 66,400 fresh & 36,400 recycle, thermal (crack, reform & visbreak) 10,600, hydrogen treat.

• **Charleston, SC** 82-6
Crude oper cap 8000.
Prin prod—3500 asphalt.

EUREKA REFINING CO 83
3328 Elm Ave, Long Beach 7, Calif. M. Nishikan, owner.

• **Long Beach, Calif**—shutdown 83-1

EVANGELINE REFINING CO, INC* 84
Box 726, Jennings, La. W. J. McBurney, Pres.

• **Jennings, La** 84-1
Crude oper cap 1500 skimming.

F

FAMARISS OIL AND REFINING CO 85
PO Box 2497, Hobbs, NM; ph Express 3-6116. V. J. Ille, VP-rfg & rfy mgr, ph Express 3-9313.

• **Hobbs, NM** 85-1
17 mi SW of Hobbs, 4 mi SW of Monument; mail and ph as above.
Crude oper cap 2000.
Prin prods—mtr gaso 1200, htg oils 400, fuel oils 400.
Fuel proc units—Platformer 750, UOP Unifiner 1000.
Key personnel—M. W. Carroll, proc supv; R. J. Downey, proc engr.
Constr plans—3000 UOP crude unit by staff, for fall-58 compl; 1000 UOP Unifiner by staff, for spring-58 compl.

FARMERS UNION CENTRAL EXCHANGE, INC* 86
Rfy Div, Box 2520, Billings, Mont; ph 3-3181.

• **Laurel, Mont** 86-1
Box 126.
Crude oper cap 19,000.

FLETCHER OIL CO* 87
24721 S Main (Box 548), Wilmington, Calif; ph Hemlock 5-9458.

• **Wilmington, Calif** 87-1
mail & ph as above.
Crude oper cap 10,000.

FLINT CHEMICAL CO* 88
2546 Clark Ave, Detroit, Mich. R. A. Flint, Pres. Parent, Howard Flint Ink Co.

• **San Antonio, Texas** 88-1
403 Somerest Rd; ph Walnut 2-0901.
Crude oper cap 230.

FOUR STATES-WESTERN OIL REFINING CO 89
Box 1877, Farmington, NM; ph Federal 4-6555. E. E. Evans, VP. Parent, Western States Refining Co.

• **Farmington, NM** 89-1
7 mi E of Farmington, on Farmington-Aztec Hwy 550.
Crude oper cap 1000.
Prin prods—mtr gaso 900, fuel oils 100.
Key personnel—R. G. Boren, Exec VP & rfy mgr; B. J. Neagle, rfy supt.

FRANKLIN REFINING CO, BEN 90
Box 2007, Tulsa, Okla; ph CH 2-7191. J. P. Dyer, Secy, Bell Oil & Gas Co. (parent company).

• **Ardmore, Okla** 90-1
¼ mi N & ½ mi E of Ardmore; Box 988, Ardmore; ph 534.
Crude oper cap 13,300.
Prin Prods—mtr gaso 6500, jet fuels 2500, htg oils 1400, fuel oils 1000, rfy gas liqs 590, asphalt 1310.
Fuel proc units—UOP fluid cat crack 7000 fresh & 7000 recycle, UOP Dubbs therm crack 2500 fresh & 2500 recycle, UOP poly prod 700.
Key personnel—E. S. Horner, mgr of rfys; L. K. Buchanan, assoc supt; R. A. Davidson, chem engr.
Constr plans—1030 b/d prod UOP HF Alky, compl Dec-57.

FRONTIER OIL REFINING CO 91
800 Ellicott Sq., Buffalo, NY; ph Mohawk 3220. Parent, Ashland Oil & Refining Co (Ky).

• **Tonawanda N Y** 91-1
Below Buffalo on Niagara River on River Rd; ph Delaware 3331.
Crude oper cap 25,500.
Prin prods—mtr gaso 10,650, jet fuels 1200, htg & diesel oils 9000, fuel oils 3000, rfy gas liqs 250, asphalt 190 t/cd.
Fuel proc units—UOP fluid cat crack 9600 fresh & 3900 recycle, cat reformer 6900, desulf 9600, UOP cat poly prod 800.
Key personnel—M. C. Sumpter, VP & rfg supt; S. A. McHie, Jr, asst rfg supt; J. Meeler, opers supv.

FRONTIER REFINING CO, THE 92
4040 E Louisiana Ave, Denver 22, Colo; ph Skyline 6-1511.

• **Florida** —planned 92-1
constr to start in near future—plans delayed by Suez situation. (See Miami Oil & Refining Co of Denver.)*

• **Cheyenne, Wyo** 92-2
2nd and Duff, SE corner of City; PO Box 418, Cheyenne; ph 7-7775.
Crude oper cap 15,500.
Prin prods—mtr gaso 7500, htg oils 3500, fuel oils 2500, rfy gas liqs 100, asphalt and road oils 1400.
Fuel proc units—UOP fluid cat crack 8000 fresh & 1000 recycle, UOP Dubbs single-coil therm crack 4500 fresh & 2750 recycle, Platformer 4500, UOP Unifiner 3500, UOP fixed-bed poly prod 450.
Key personnel—P. A. Kahle, VP-mfg; J. L. Olvey, asst rfy mgr.
Constr plans—5500-7500 crude and vac unit, onstream 7-57.

G

GENERAL PETROLEUM CORP* 93
612 Flower St, Los Angeles 54, Calif. Parent Socony Mobile Oil Co, Inc.

• **Los Angeles, Calif*** 93-1
2721 E 37th St, Los Angeles 54, Calif.
Prin prods—lubes and proc prods.

• **Torrance, Calif*** 93-2
3700 W 190 St, Torrance, Calif.
Crude oper cap 125,000.

• **Ferndale, Wash*** 93-3
on Puget Sound, 12 mi S of Canadian Border & 7 miles W of Ferndale; Box 8, Ferndale.
Crude oper cap 35,000.

GILLEY OIL & REFINING CO* 94
Betsy Lane, Ky.

• **Betsy Lane, Ky**—shutdown 94-1
Crude oper cap 300 skimming.

GLADEWATER REFINING CO 95
Box 888, Gladewater, Tex; ph 2295.

• **Gladewater, Texas** 95-1
2 blks S of Hwy 80; mail & ph as above.
Crude oper cap 2500.
Prin prods—mtr gaso 1200, htg oils 500, fuel oils 675.
Fuel proc units—therm crack 1200, Catformer 900, Calif poly prod 90.
Key personnel—H. F. Richardson, rfy mgr; A. L. Miles, rfy supt.

GOLDEN BEAR OIL CO 96
325 W 8th St, Los Angeles, Calif; ph MI 8261. D. D. Davidson, mgr-mfg & engrg.

• **Oildale, Calif** 96-1
Manor St, NE Oildale; Box 446, Oildale; ph Export 9-3391.
Crude oper cap 2500.
Prin prods—lube oil 1600, asphalt 800.
Key personnel—M. B. Pardew, rfy mgr; R. P. Neal, rfy supt; L. Liles, opers supt.
Constr plans—4000 extension for vac dist by D. G. Reynolds & staff, onstream 4-1-57; 1200 Texaco furfural extrac by D. G. Reynolds & staff onstream Dec-57; planning hydrotreat unit, for compl late-58 early-59.

GRATEX CORP 97
PO Box 397, Graham, Tex; ph 430. (Formerly G&B Oil Co.)*

• **Graham, Texas** 97-1
mi N of Graham on St Hwy 24; mail & ph as above.
Crude oper cap 500.
Prin prods—mtr gaso 150, htg oils 125, fuel oils 185, greases 20.
Key personnel—L. D. Pope, VP genl mgr.

GREAT NORTHERN OIL CO 98
PO Box 3596, St. Paul 1, Minn; ph CApital 2-4721.

• **Pine Bend, Minn** 98-1
14 mi SE of St Paul at junction of Hwys 52, 55 & 56; mail & ph as above.
Crude oper cap 30,000.
Prin prods—mtr gaso 15,000 b/sd, fuel oils 8000 b/sd, rfy gas liqs 1000 b/sd, coke 500 t/sd.
Fuel proc units—TCC Cat Crack 12,500 b/sd fresh & 12,500 b/sd recycle, Ultraformer 5000 b/sd, Std Ind hydrodesulf 16,000 b/sd (5000 for cat reformer feed, 3500 for No. 1 fuel oil, 4500 for No. 4 fuel oil, 3000 for hvy naphtha), delayed coking 10,000 b/sd, UOP cat poly prod 1000 b/sd.
Key personnel—A. S. Gilliam, plt mgr; L. Lundahl, chf engr.

GREAT PLAINS REFINERY & DEVELOPMENT CO* 99
Rapid City, SD. A. Gordon, Pres.

• **Rapid City, SD**—building 99-1
Crude oper cap 3000.

GULF OIL CORP 100
PO Box 1166, Pittsburgh 30, Pa; ph EX 1-2400. B. H. Barnes, VP-opers.

• **Staten Island, NY** (New York Rfy) 100-1
Forest & Western Aves, near entrance of Goethals Bridge at extreme W end of Forest Ave. PO Box "M", Staten Island 2; ph Gibraltar 2-8000.
Crude oper cap 12,942 oper, 4,058 idle.
Prin prods—mtr gaso 857, htg oils 1820, fuel oils 10,222.
Fuel proc units—Crude topping unit 17,000.
Key personnel—W. M. Braybrooks, genl mgr; A. H. Grant, mgr-opers.

• **Cleves, Ohio** (Cincinnati Rfy) 100-2
25 mi W of downtown Cincinnati, ¼ mi off

Rt 50 on Hwy 128, PO Box 7, Cleves; ph Willow 1-3400.
Crude oper cap 32,000.
Prin prods—mtr gaso 18,800, htg oils 4500, fuel oils 2300, rfy gas liqs 313, asphalt 2600.
Fuel proc units—fluid cat crack 12,600 fresh & 5400 recycle, therm crack 5640, Platformer 9500, poly prod 1422.
Key personnel—A. A. Niehenke, genl mgr; L. L. Laster, mgr-opers; W. S. Reeder, mgr-engrg.

• **Toledo, Ohio** **100-3**
2935 Front St (PO Box 1023) Toledo 1; ph Pontiac 2676.
Crude oper cap 42,000.
Prin prods—mtr gaso 17,420, htg oils 11,340, fuel oils 5,040, rfy gas liqs 1000.
Fuel proc units—Kellogg cat crack 15,500 fresh & 2000 recycle, Gulf therm crack 2000 fresh & 3000 recycle, Platformer 10,000, Kellogg poly prod 3455.
Key personnel—D. E. Hart, genl mgr; H. A. Bailey, mgr-opers.

• **Philadelphia, Pa** **100-4**
30 th St & Penrose Ave, SW Philadelphia; PO Box 7408, Philadelphia 1; ph HOward 5-3100.
Crude oper cap 183,000 (incl 5170 gas oil during 561.
Prin prods—mtr gaso 76,165, avgas 2740, htg oils 56,715, fuel oils 49,110, lube oil 1000, rfy gas liqs 520, waxes 15.
Fuel proc units—Kellogg fluid cat crack 18,090 fresh & 8510 recycle, Kellogg fluid cat crack 38,930 fresh & 18,320 recycle, Platformer 14,400, Gulf naphtha Polyforming 7200 fresh & 7200 recycle, Gulf reduced crude visbreak 20,250, UOP cat poly prod 3500, sulf acid alky prod 3100, Gulf naphtha Polyforming 4000 fresh & 4000 recycle (idle).
Key personnel—J. O. Timms, genl mgr; R. J. Metcalf, mgr-opers; T. A. Dietz, mgr-engrg.
Constr plans—two 20,000 Gulfining units by Kellogg, onstream June-57; 3500 Texaco sulf acid alky by Parsons, onstream Aug-57; 26,000 Platformer by Procon, onstream Dec-57; 26,000 Platformer by Procon, onstream Feb-59.

• **Charleston, SC***—tentative **100-5**
exercised option on 280-acre tract near Charleston as tentive location for new refinery.

• **Port Arthur, Texas** **100-6**
W Port Arthur; PO Box 701; ph YU 3-3301.
Crude oper cap 282,000.
Prin prods—mtr gaso 108,000, avgas 6000, htg oils 80,000, fuel oils 44,000, lube oil 12,500, rfy gas liqs 6000, greases 42 t/cd, waxes 51 t/cd.
Fuel proc units—Kellogg fluid cat crack 47,000 fresh & 17,000 recycle, Kellogg fluid cat crack 44,000 fresh & 15,000 recycle, TCC cat crack (Houdry) 24,000 fresh, therm crack 10,500 fresh & 18,000 recycle, Platformer 27-200, Gulf naphtha Polyform 17,000 fresh & 15,000 recycle, Gulfining 42,500, 2 visbreakers 11,000 ea (converted therm units), UOP propylene poly prods 3500, Texaco sulf acid alky 3100 & 1300.
Key personnel—R. C. Faulkner, genl mgr; J. N. Miller, dir-proc engrg dept; T. F. Hogan, mgr-opers div.
Constr plans—26,000 Platformer by Procon, onstream early-58; 3300 alky expan by Kellogg, onstream early-57; 2800 UOP propylene poly unit expan by Procon, onstream summer-57; 125 t/sd Monsanto-Sanneborn acid sludge decomposers.

H

HANCOCK OIL CO **101**
PO Box 810, Long Beach 1, Calif; ph GArfield 7-7911.

• **Long Beach, Calif** **101-1**
2828 Junipero Ave, Signal Hill, Calif; mail & ph as above.
Crude oper cap 18,900.
Prin prods—mtr gaso 7600, htg oils 2100, fuel oils 8820, rfy gas liqs 380.
Fuel proc units—Socony cat crack 6000 fresh & 4000 recycle; therm crack 1800 fresh & 7200 recycle; Ultraformer 2400, Std Ind hydrotreat 2400, visbreak 8500 fresh & 4000 recycle, UOP poly prod 500.
Key personnel—W. T. Hancock, Exec VP & rfy mgr; H. C. Burney, asst to rfy mgr; J. D. Studds, asst rfy mgr; J. R. Bruner, proc engr.

HARBOR REFINING CO* **102**
2542 South St, Long Beach, Calif; ph Garfield 2-2448.

• **Long Beach Calif**—shutdown **102-1**
Crude oper cap (when oper) 5000.

HARMONY OIL CORP **103**
808 N Michigan Ave, Chicago, Ill.

• **Salem, Ill**—shutdown **103-1**
mi S of Salem & mi W on Hwy 50; PO Box 356, Salem; ph 1920.
Crude oper cap 3000 idle.
Fuel proc units—skimming, treating, lead.

HARPER & TURNER OIL CO* **104**
Edmond, Okla.

• **Edmond, Okla**—shutdown **104-1**
Crude oper cap (when oper) 1500.

HART REFINERIES* **105**
Missoula, Mont.

• **Missoula, Mont**—shutdown **105-1**
Crude oper cap (when oper) 750 skimming.

HOT SPRINGS REFINING CO* **106**
Hot Springs, S Dak.

• **Hot Springs, SD**—idle **106-1**
Crude oper cap (when oper) 200 skimming.

HOWELL REFINING CO **107**
PO Box 7188 Hackberry Sta, San Antonio, Tex; ph LEhigh 4-6147. P. N. Howell, Pres.

• **San Antonio, Tex** **107-1**
S of San Antonio on Hwy 181; mail & ph as above.
Crude oper cap 3000.
Prin prods—mtr gaso 1250, jet fuels 1500, htg oils 250, rfy gas liqs 100.
Key personnel—A. I. Robertson, supt.

HUMBLE OIL & REFINING CO **108**
PO Box 2180, Houston 1, Tex; ph CA 5-4411.

• **Baytown, Tex** **108-1**
30 mi E of Houston in Baytown; PO Box 3950; ph Baytown 8121.
Crude oper cap 261,800 oper, 20,200 idle.
Fuel proc units—fluid cat crack (2 units) 95,300, tank & tube therm crack 14,900, Ultraformer (2 units) 36,800, Hydrofining (3 units) 78,200, tank & tube visbreak 20,200, cat poly prod 4000, H_2SO_4 alky prod 10,200.
Key personnel—G. L. Farned, plts mgr; J. Harrop, genl supt; E. F. Voss, chf engr-rfg.
Constr plans—fluid cat crack 51,200 by Foster Wheeler, onstream 2-15-58; 86,400 hydrodesulf (2 units) by Parsons, No. 1 onstream 11-18-57, No. 2 onstream 1-1-58; 2300 alky expan by staff, compl 6-1-57.

HUNT, D. EUGENE **109**
222-2nd Ave S, Lewistown, Mont; ph 1094. D. Eugene Hunt, owner & mgr rfg.

• **Winnett, Mont**—idle **109-1**
Crude oper cap (when oper) 300 skimming. Could be put in operation within 90 days.

HUNT OIL CO **110**
700 Mercantile Bank Bldg, Dallas 1, Tex; ph Riverside 1-3561.

• **Tuscaloosa, Ala** **110-1**
mi S of city limits; PO Box 482; ph PLaza 4-6675.
Crude oper cap 7000.
Prin prods—mtr gaso 1600, jet fuels 1400, htg oils 100, fuel oils 1050, asphalt 2000.
Key personnel—C. A. Peterson plt supt; I. Miller, plt engr.

HUSKY OIL CO **111**
Box 380, Cody, Wyo; ph 500.

• **Cody, Wyo** **111-1**
Crude oper cap 6500.
Prin prods—mtr gaso 1300, htg oils 105, fuel oils 190, asphalt 450 t/cd.
Fuel proc units—Catformer 1000, Diesulformer 1000.
Key personnel—K. E. Dyer, mgr rfg; J. A. Mullin, rfy supt; F. B. Odasz, mgr of development and control.

I

INDIANA FARM BUREAU COOPERATIVE ASSN, INC. **112**
47 S Pa. St, Indianapolis, Ind; ph ME 1-8361.

• **Mount Vernon, Ind** **112-1**
mi NE of Mt. Vernon; PO Box 271, Mt Vernon; ph Poplar 3-4411.
Crude oper cap 12,000.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

Prin prods—mtr gaso 6240, htg oils 3240, fuel oils 2040.
Fuel proc units—Platformer 3000, UOP Unifiner 2100.
Key personnel—M. R. Bradley, secy and asst treas.

INGRAM OIL & REFINING CO **113**
1205 Hibernia Natl Bank Bldg, New Orleans, La; ph MAgnolia 6621. Parent, Ingram Products Co.

• **Meraux, La** **113-1**
12 mi below New Orleans (Canal St) on St Bernard Hwy; PO Box 1550, Chalmette, La; ph EDgewood 1-4141.
Crude oper cap 17,000.
Prin prods—mtr gaso 8500, htg oils 6000, fuel oils 1750.
Fuel proc units—UOP fluid cat crack 4500 fresh & 2500 recycle, Platformer 3000, UOP cat poly prod 500.
Key personnel—J. A. O'Neill, St, VP; R. H. Gasaway, supt; J. A. O'Neill, Jr, tech dir; C. B. Whyte, Jr, plt engr.

INTERNATIONAL REFINERIES, INC **114**
227 N Colfax Ave, Minneapolis 5, Minn; ph FRanklin 4-3660.

• **Wrenshall, Minn** **114-1**
PO Box 8, Wrenshall; ph EVergreen 4-4245.
Crude oper cap 11,000.
Prin prods—mtr gaso, jet fuel, htg oils, resid fuels.
Fuel proc units—Esso Model IV cat crack 3250 fresh & 1750 recycle, Calif Poly prod 270.
Key personnel—L. G. Alexander, VP & genl mgr; L. W. Mardaga, rfy genl supt; J. T. Zeien, asst rfy genl supt.
Constr plans—2800 Hydrofiner-Powerformer by R. M. Parsons Co, due onstream 4-57.

J

JARVIS REFINING CO **115**
447 Standard Office Bldg, Decatur, Ill; ph 3-3401.

• **Troy, Ind** **115-1**
½ mi W of Troy on Hwy 66; Box 5, Troy; ph 66.
Crude oper cap 100 oper, 1400 idle.
Prin prods—mtr gaso 20, htg oils 20, fuel oils 59.
Key personnel—W. T. Walker, rfy supt.

• **Somerset, Ky** **115-2**
mi S of Somerset on Hwy 27; Drawer 631, Somerset; ph 982.
Crude oper cap 1000 oper, 500 idle.
Prin prods—mtr gaso 260, htg oils 280, fuel oils 350.
Fuel proc units—Cycloversion cat reform 400.
Key personnel—W. T. Walker, rfy supt.

JET FUEL REFINERY CO* **116**
Box 1724, Billings, Mont.

• **Mosby, Mont** **116-1**
Crude oper cap 400 oper, 850 idle.

K

KENDALL REFINING CO* **117**
Bradford, Pa; ph 6111. J. B. Fisher, Pres & genl mgr.

• **Bradford, Pa** **117-1**
77 N Kendall Ave.
Crude oper cap 5000.

KERR-McGEE INDUSTRIES, INC **118**
Kerr-McGee Bldg, 306 N Robinson, Oklahoma City 2, Okla; ph RE 9-0611. R. M. Chesney, VP-rfg. (Formerly Deep Rock Oil Co.)*

• **Cleveland, Okla**—shutdown **118-1**
1½ mi W of Cleveland on US Hwys 64 & 99; Box 398, Cleveland; ph 521.
Crude oper cap (when oper) 6500.
Prin prods—mtr gaso 3000.
Fuel proc units—UOP 2-coil selective therm crack 3500 fresh & 7000 recycle, Platformer 1800.
Key personnel—W. J. Leenhouts, rfy mgr; F. P. Frey, proc supt.

• **Cushing, Okla** **118-2**
2 mi N of Cushing; Box 1031, Cushing; ph CA 5-0900.
Crude oper cap 22,000.
Prin prods—mtr gaso 7000, jet fuels 1000, htg oils 5200, fuel oils 900, lubes 900, rfy gas liqs 400, asphalt 96 t/cd.
Fuel proc units—UOP fluid cat crack 7500 fresh & 3000 recycle, UOP poly prod 400.
Key personnel—R. E. Feasel, rfy mgr; T. C. Woods, prod control supt; R. W. Davis, chf engr.

Kerr-McGee Industries, Inc (cont)

• **Wynnewood, Okla**.....118-3
S of city on Hwy 77; Box 125, Wynnewood; ph MO 5-3311.
Crude oper cap 16,000.
Prin prods—mtr gaso 7500, jet fuels 1200, htg oils 3000, fuel oils 800, asphalt 3300, rfy gas liqs 350.
Fuel proc units—UOP fluid cat crack 6000 fresh & 4000 recycle.
Key personnel—H. Miller, rfy mgr; W. E. Ward, chf engr.
Constr plans—5500 Platformer, onstream 1958; 4000 UOP distillate treater, onstream 1958.

L

LAKE SUPERIOR REFINING CO.....119
East End, Superior, Wisc; ph Export 8-3533; E. F. Nelson, Pres & rfy mgr.

• **Superior, Wisc**.....119-1
2 mi SW of East End of Superior on Stinson Ave; mail & ph as above. (This was Carter Oil Co's Cut Bank, Mont, refinery purchased in 1950 and re-erected at Superior by Refinery Engineering Co)*
Crude oper cap 6500.
Prin prods—mtr gaso 1800, htg oils 1200, fuel oils 1200.
Fuel proc units—Dubbs therm crack 1500 fresh & 1500 recycle, Platformer 1000.
Key personnel—H. H. West, supt; J. I. Lanctot, asst supt; P. C. Bilger, chf engr.
Constr plans—10,000 UOP crude unit, 2000 UOP dist Unifiner, 2300 UOP naphtha Unifiner, 2000 Platformer, all by Procon, onstream 10-15-57.

LAKESIDE REFINING CO*.....120
Box 909, Kalamazoo, 99, Mich; ph Fireside 3-1574. E. Fleischman, Pres.

• **Kalamazoo, Mich**.....120-1
Crude oper cap 300.

LEONARD REFINERIES, INC.....121
Alma, Mich; ph Alma 661. J. S. Pfarr, adm VP-mfg.

• **Alma, Mich** (Leonard Rfy Div).....121-1
E Superior St, Alma; ph 661.
Crude oper cap 9500.
Prin prods—mtr gaso 4800, jet fuels 600, htg oils 2750, fuel oils 1750, asphalt 1900, LPG 130.
Fuel proc units—TCC cat crack 6000 fresh & 750 recycle, Ultraformer 2200, hydrofine (ref feed) 2200, hydrofine (other) 5200, UOP poly 90.
Key personnel—R. W. Pollard, rfy mgr; C. E. Weaver, opers supt.

• **Alma, Mich** (Mid-West Rfy Div).....121-2
1071 Ferris St, Alma; ph Alma 43. (Formerly Mid-West Refineries, Inc.)*
Crude oper cap 10,000.
Prin prods—mtr gaso 2850, htg oils 2370, fuel oils 1500.
Fuel proc units—Dubbs therm crack 3150, Platformer 2000 (1800 fresh), UOP poly 65.
Key personnel—E. E. Thompson, rfy mgr; R. L. Brown, opers supt.

• **Mt. Pleasant, Mich** (Roosevelt Rfy Div).....121-3
Formerly Roosevelt Oil & Refining Corp.*
Crude oper cap 7600.
Prin prods—mtr gaso 1400, htg oils 1350, fuel oils 750.
Fuel proc unit—Platformer 1600.
Key personnel—T. J. Williams, rfy mgr; B. Weber, opers supt.

LION OIL CO.....122
El Dorado, Ark; ph Union 3-3111; J. B. Rogerson, VP, Div of Monsanto Chemical Co.

• **El Dorado, Ark**.....122-1
end of McHenry Ave, SW side of city; ph Union 3-4111.
Crude oper cap 28,229.
Prin prods—mtr gaso 9675, kerosine 2025, htg oils 5178, fuel oils 2821, lube oil 484, rfy gas liqs 252, greases 16, asphalt & derivs 2366.
Fuel proc units—TCC cat crack 5000 fresh & no recycle, fluid cat crack 5000 fresh & 5000 recycle, phos acid poly prod 900, sulf acid alky prod 1200.
Key personnel—W. M. Carney, rfy mgr; J. L. Ricks, engrg supt; M. M. Moody, proc supt; C. A. Hardcastle, engrg supvr.

LOUISVILLE REFINING CO.....123
PO Box 2039, Louisville 11, Ky; ph SP 2-3641. Parent, The Farm Bureau Cooperative Assn.

• **Louisville, Ky**.....123-1
1300 Southwestern Parkway; mail & ph as above.
Crude oper cap 6781.
Prin prods—mtr gaso 4352, htg oils 974, fuel oils 1300.
Fuel proc units—UOP fluid cat crack 3102 fresh & 651 recycle, Dubbs therm crack 1739 fresh & 6956 recycle, UOP poly prod 400, UOP Unifiner-Platformer 2000.
Key personnel—C. H. Vos Koetter, genl mgr; J. J. Loudermill, rfy supt; H. Estes, plt engr.

LUNDAY THAGARD OIL CO.....124
Box 151, South Gate, Calif; ph LO 6-5330.

• **South Gate, Calif**.....124-1
mail and ph as above.
Crude oper cap 1700.
Prin prod—asphalt roofing.
Key personnel—R. Page, rfy supt.

M

McMILLAN PETROLEUM CORP*.....125
530 W 6th St, Room 1010, Los Angeles 14, Calif; ph Vandike 2241. R. S. MacMillan, Pres.

• **Norphlet, Ark**.....125-1
Crude oper cap 4000.

• **Long Beach, Calif**.....125-2
2020 Walnut St; ph Garfield 4-8515.
Crude oper cap 8000.

MAGNOLIA PETROLEUM CO.....126
PO Box 900, Dallas 21, Tex; ph RI 2-4131. Parent, Socony Mobil Oil Co, Inc.

• **Beaumont, Tex**.....126-1
Approx 5 mi S of Hwy 90; PO Box 3311, Beaumont; ph TE 3-9411.
Crude oper cap 200,000.
Fuel proc units—TCC cat crack 76,000 fresh & 13,400 recycle, TCR 16,000, Sovaformer 19,300, Polyform 12,400, visbreak 45,000, therm poly prod 1700, H_2SO_4 alky prod 5750.
Key personnel—J. W. Newton, VP & rfy mgr; L. M. Fabian, genl supt; G. C. Defrey, chf engr.
Constr plans—100,000 crude unit by Foster Wheeler, onstream mid-58; 8000 alkylation by Braun & Staff, onstream early-58.

MALCO REFINERIES, INC.....127
PO Box 660, Roswell, NM; ph MAin 2-3140. J. W. Lackey, VP. Subsid, Wilshire Oil Co of Calif.

• **Artesia, NM**.....127-1
E Main St, Artesia; mail & ph as above. Formerly New Mexico Asphalt & Refining Co.
Crude oper cap 12,000.
Prin prods—mtr gaso 2940, jet fuels 4050, htg oils 2310, fuel oils 660, rfy gas liqs 660, asphalt 1380.
Fuel proc units—TCC cat crack 4620 fresh & 1380 recycle, UOP poly prod 400.
Key personnel—J. Whitehurst, genl rfg supt; W. M. Tipps, plt supt; B. C. Gleghorn, asst plt supt.
Constr plans—900 UOP HF alky by Grebe & Doremus, onstream 8-1-57.

• **Grants, NM**.....127-2
sold to El Paso Natural Gas Products Co.

• **Roswell, NM**—shutdown.....127-3
refinery has been dismantled

MANESPO REFINING CO.....128
3380 Elm Ave (PO Box 7172), Long Beach, Calif; ph GArfield 7-5437.

• **Long Beach, Calif**.....128-1
heart of city, 4 mi N of Ocean Blvd; mail & ph as above. Refinery purchased from the Government in 1955, revamped and repaired. Operations started Feb-56.
Crude oper cap 5000.
Prin prods—mtr gaso 1000, htg oils 1000, fuel oils 3000, rfy gas liqs 20.
Key personnel—E. W. Smith, mgr of mfg; L. Wells, rfy supt; M. A. Nishkian, chf engr.

MARVEL REFINING CO*.....129
2019 Chicago Dr, SW, Grand Rapids, Mich; ph CH 5-9137. F. S. Grimes, Pres.

• **Grand Rapids, Mich**.....129-1
mail & ph as above.
Crude oper cap 2000 skimming.
Key personnel—C. A. Mitchell, rfy supt.

McMURREY REFINING CO.....130
Box 840, Tyler, Tex; ph 2-3861.

• **Tyler, Texas**.....130-1
2 mi E of downtown Tyler, near intersection of McMurrey Dr & Commerce St; mail & ph as above.
Crude oper cap 17,500 oper, 5000 idle.
Prin prods—mtr gaso 10,000 avgas 3000, htg oils & diesel fuel 2000, fuel oils 1000, rfy gas liqs 850, coke 100 t/cd.
Fuel proc units—UOP fluid cat crack 8500 fresh & 1500 recycle, Dubbs 2-coil therm crack 4500 fresh & 5500 recycle, Platformer 5500, delayed coker 9500 fresh & 500 recycle UOP cat poly prod 700, sulf alky prod 2400.
Key personnel—O. C. DeLoach, genl supt; L. C. Frady, asst to supt; W. G. Rolf, plt engr; D. W. Caswell, chf engr.

MERCURY OIL REFINING CO*.....131
Box 1128, Oklahoma City 1, Okla; ph Melrose 8-3383. W. E. Anderson, Pres.

• **Oklahoma City, Okla**.....131-1
Crude oper cap 5000.

MIAMI OIL & REFINING CO OF DENVER*.....132
proposed West Palm Beach, Fla, refinery by The Frontier Refining Co. Formerly Seminole Oil & Refining Co.

• **West Palm Beach, Fla**—planned.....132-1
ODM FTA approval for $11,485,000, issued 1955.
Crude oper cap 15,000.

MID-AMERICA REFINING CO, INC*.....133
Box 31, Chanute, Kans; ph 535. O. H. Cunningham, Pres. Formerly MFA Oil Co.

• **Chanute, Kans**.....133-1
mail & ph as above.
Crude oper cap 2000.

MIDLAND COOPERATIVES, INC.....134
739 Johnson St, NE, Minneapolis 13, Minn; ph STerling 1-9571. A. Waller, mgr petrol dept.

• **Cushing, Okla**.....134-1
in Cushing (Box 1111); ph Capital 5-4610.
Crude oper cap 13,000.
Prin prod—mtr gaso 7300.
Fuel proc units—fluid cat crack 5000 total, visbreak 6000, Platformer 2600.
Key personnel—C. A. Carlson, rfy mgr; T. B. Randall, rfy supt.

MODERN OIL CO.....135
217 Hedden Bldg, Billings, Mont; ph 6-6760. J. Wight, Pres.

• **Shelby, Mont**—shutdown.....135-1
mail and ph as above. (Bought from North Star Refining Co.)*
Crude oper cap (when oper) 1500.
Prin prods—mtr gaso, jet fuels, htg oils fuel oils.

MOHAWK PETROLEUM CORP*.....136
405 Montgomery St, San Francisco, Calif. A. L. Marsten, Pres.

• **Bakersfield, Calif**.....136-1
Rosedale Hwy; Box 1476; ph Fairview 4-9651.
Crude oper cap 7500 oper, 3500 idle.

MONARCH REFINERIES, INC.....137
Box 1283, Oklahoma City, Okla; ph FO 5-7381. W. E. Steelman, Pres.

• **Oklahoma City, Okla**.....137-1
mail and ph as above.
Crude oper cap 1000 oper, 3000 idle.
Prin prod—asphalt 100 t/cd.
Key personnel—S. R. Hardy, rfg supt.

MONARCH REFINING CO*.....138
516 N San Marcos St (Box 4457, Sta A), San Antonio, Tex; ph Capitol 6-6233. W. H. Olmstead, Pres.

• **San Antonio, Texas**.....138-1
Crude oper cap 2500 skimming.

N

NAPH-SOL REFINING CO*.....139
Box 207, Muskegon, Mich; ph 4-1656. W. E. Anderson, Pres & genl mgr.

• **Muskegon, Mich**.....139-1
mail & ph as above.
Crude oper cap 5100.

NATIONAL COOPERATIVE REFINERY ASSN.....140
PO Box 770, McPherson, Kans; ph 2060.

• **McPherson, Kans**.....140-1
2 mi S on city rt Hwy 81 & ½ mi W from city; mail & ph as above.
Crude oper cap 26,000.
Prin prods—mtr gaso 13,200, jet fuels 125, htg oils 9600, fuel oils & diesel 1200, rfy gas liqs 550, coke 245 t/cd.
Fuel proc units—UOP fluid cat crack 11,000 fresh & 5000 recycle, therm crack 1800 fresh & 5400 recycle (about 50% of cap utilized), Platforming 4000, UOP delayed coke 11,000, UOP cat poly prod 900 (300 cap used when alky unit operating), UOP HF acid alky prod 1700.
Key personnel—H. P. Andrews, rfy mgr; G. N. Kavouras (coca supt; J. A. Bierbaum tech dir; J. M. Holecek, mech engr.

NATIONAL REFINING CO 141
essner Ave, Findlay, Ohio; ph 2560. Parent, shland Oil & Refining Co (Ky).

•Findlay, Ohio 141-1
W city limits; mail & ph as above.
Crude oper cap 15,000.
Prin prods—mtr gaso 5325, jet fuels 2000, htg oils 3400, fuel oils 1600, lube oil 560, greases 8,600 lb/cd, waxes 33, asphalt 300 t/cd.
Fuel proc units—Dubbs therm crack 4700 fresh & 12,300 recycle, therm reform 1350, UOP cat poly prod 160.
Key personnel—C. West, rfy supt; D. B. Queen, opers supt.

NAVAJO REFINERIES* 142
Albuquerque, N Mex.

• Albuquerque, NM—planned 142-1
ODM FTA approved for $10-million, issued 1954.
Crude oper cap 10,000.

NEWHALL REFINING CO, INC 143
Box 638, Newhall, Calif; ph 355. W. D. Parks, Pres.

• Newhall, Calif 143-1
mail & ph as above.
Crude oper cap 3000 oper, 975 idle, skimming.
Prin prods—mtr gaso 291, htg oils 328, fuel oils 780, road oils & asphalt 616.
Key personnel—J. Parton, plt supt.

NORTH AMERICAN PETROLEUM CORP 144
PO Box 968, Corpus Christi, Tex; ph TUlip 4-4085. V. VerMilyea, Pres.

• Corpus Christi, Texas—planned 144-1
construction will not start for 1-2 years at earliest. Property may be used for another purpose.

NORTHWESTERN REFINING CO* 145
Box 248, St Paul Park, Minn; ph LA 9771. A. T. Erickson, Pres.

•New Brighton, Minn 145-1
Crude oper cap 3000 skimming.

• St Paul Park, Minn 145-2
mail as above.
Crude oper cap 14,000.

O

OHIO OIL CO, THE 146
539 S Main St, Findlay, Ohio; ph Findlay 2700. R. E. Luton, VP of rfg.

• Robinson, Ill 146-1
SE corner of Ill Central and NY Central RR intersection on SE edge of town; mail; Rfy Office Bldg, Robinson, Ill; ph Robinson 611.
Crude oper cap 42,000.
Prin prods—mtr gaso 25,100, avgas 1900, htg oils 11,000, fuel oils 700, rfy gas liqs 800, coke 1800 t/cd.
Fuel proc units—UOP fluid cat crack 18,500 fresh & 8,500 recycle, Holmes-Manley therm crack 6600 fresh & 15,000 recycle, Houdriformer 8000, Holmes-Manley therm reform 2200, Houdry Hydropretreat 8000, Lummus delayed coking 6000 fresh & 600 recycle, UOP phos acid poly prod 1600, UOP H_2SO_4 alky prod 2050.
Key personnel—H. E. Handy, rfy mgr; D. L. Winsett, rfy supt; B. B. Miller, asst supt.
Constr plans—cat gaso debutanizer tower and cat gaso rerun tower by Catalytic Construction Co, onstream 1957; qual control lab by Sam Emmerson Co, compl 1957; water cooling tower by J. F. Pritchard & Co, compl 1957.

• Lovell, Wyo 146-2
leased to Big Horn Refining Co.
Crude oper cap 6500.

ORIENTAL REFINING CO* 147
Box 118, Denver, Colo; ph Acoma 2-2527. E. M. Stringer, Pres.

• Alamosa, Colo 147-1
Box 390.
Crude oper cap 2000.

• Denver, Colo 147-2
Crude oper cap 4000.

OSCEOLA REFINING CO, INC 148
521 N Park, Reed City, Mich; ph TEnnyson 7-4431. R. Andres, Pres; A. Hansen, exec VP. Subsid, West Branch Refineries, Inc.

• Reed City, Mich 148-1
Address & ph as above.
Crude oper cap 1700.
Prin prods—mtr gaso 12,000 bbl/mo, htg oils 17,000 bbl/mo, fuel oils 12,000 bbl/mo.
Key personnel—F. Bacon, supt; G. Lee, asst supt.

OXNARD OIL & REFINING CO 149
PO Box 1429, Oxnard, Calif; ph Hunter 3-5910; C. C. Kohlhaas, partner.

• Oxnard, Calif 149-1
mail & ph as above.
Crude oper cap 1500.
Prin prods—htg oils 300, fuel oils 300, asphalt 800.
Key personnel—E. Vacca, genl mgr-opers.

P

PALOMAR OIL & REFINING CO* 150
Shell Rd, Bakersfield (PO Box 1736), Calif; ph Fairview 5-5941. T. E. Fisher, Pres.

• Bakersfield, Calif 150-1
Crude oper cap 1230.

PALUXY ASPHALT CO* 151
Box 57, Yazoo City, Miss; ph 1212.

• Yazoo City, Miss 151-1
Crude oper cap 5600.

PAN-AM SOUTHERN CORP*
merged into American Oil Co by parent, Standard Oil Co (Ind).

PAN AMERICAN REFINING CORP*
merged into American Oil Co by parent, Standard Oil Co (Ind).

PANA REFINING CO 152
PO Box 57, Pana, Ill; ph 4480. Parent, Illinois Farm Supply Co.

• Pana, Ill 152-1
½ mile S of Pana on Rt 51; mail as above.
Crude oper cap 5000.
Prin prods—mtr gaso 2000, htg oils 1100, fuel oils 1050.
Fuel proc units—Dubbs therm crack 2200, Platformer 650, UOP poly prod 100.
Key personnel—R. H. Carroll, mgr; D. A. Ward, supt; A. Blanco, chf engr.
Constr plans—expansion program under consideration.

PANHANDLE OIL CO*
merged into American Petrofina, Inc during 1956.

PATTON OIL CO 153
Box 337, Rotan, Tex; ph 291.

• Rotan, Texas—shutdown 153-1
plt to be dismantled.

PEERLESS TANK CLEANING CO, INC 154
PO Box 1275, Kilgore, Tex; ph 3434.

• Kilgore, Texas—idle 154-1
2200 block of N Longview St in Kilgore.
Crude oper cap (when oper) 150. Topping and dehydrating plant—not refinery.
Key personnel—M. M. Stack, rfy supt.

PENNSYLVANIA REFINING CO 155
Butler, Pa; ph Butler 7-2781. J. A. Beck, Jr., VP.

• Karns City, Pa 155-1
in Karns City; ph Petrolia 2430.
Crude oper cap 1300.
Prin prods—mtr gaso 350, htg oils 340, fuel oils 115, lube oil 390, waxes 800.
Key personnel—J. A. Beck, Jr, VP (rfy mgr); L. E. Sherwin, prod supt; R. Lachman, engr.

PETROLEUM OPERATORS CORP* 156
2679 Arapahoe St, Boulder Colo; ph Hillcrest 2-3640. E. J. Klaeger, Pres.

•Badger Basin, Wyo—shutdown 156-1
Crude oper cap (when oper) 1000.

PETROLEUM PRODUCTS CO 157
Lueders, Tex; ph 100. A. B. Foster, Secy-Treas.

• Lueders, Tex 157-1
on Hwy 380; address and ph as above.
Crude oper cap 3000.
Fuel proc units—UOP Dubbs therm crack 450 fresh & 2400 recycle.
Key personnel—J. J. Bledsoe, VP (rfy mgr); R. Counts, rfy supt.

PETROLEUM SPECIALTIES, INC* 158
Box 448, Treatnon, Mich; ph (Detroit) Woodward 5-5075. C. H. Alberding, Pres.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

• Flat Rock, Mich 158-1
ph Sterling 2-2425.
Crude oper cap 6500.

PETROLITE CORP 159
408 Olive St, St Louis 2, Mo; ph CHestnut 1-8370. W. J. Nuelle, VP.

• Barnsdall, Okla (Bareco Wax Co Div). 159-1
S of Barnsdall (Box B).
Feedstock petrolatum.
Prin prods—microcrystalline waxes 65 t/cd.
Key personnel—L. M. Keene, rfy supt; G. L. Meyers, asst rfy supt.

• Kilgore, Tex (Bareco Wax Co Div) 159-2
S boundary of Kilgore, on State Hwy 259; Box 390, Kilgore; ph 5077.
Crude oper cap 475 oper, 275 idle.
Prin prods—waxes 23 t/cd.
Key personnel—R. F. Scivally, VP & genl mgr; E. C. Livingston, plt supt; A. W. Marshall, chem engr.

PHILLIPS PETROLEUM CO 160
Bartlesville, Okla; ph 6600.

• Kansas City, Kans 160-1
Fairfax Dist; PO Box 268, Kansas City 17, Kans; Ph FI 2-4800.
Crude oper cap 57,000.
Fuel proc units—fluid cat crack 24,000 fresh & 16,000 recycle, Platformer 16,000, cat poly prod 1700.
Key personnel—V. C. Cavin, supt; B. F. Wobker, asst supt; H. R. Lamborn, chf plt engr.

• Great Falls, Mont 160-2
PO Box 1239, Great Falls; ph 4-4371.
Crude oper cap 2700.
Fuel proc units—Dubbs therm crack 1200.
Key personnel—P. Jones, supt; C. A. Borsheim, opers supt; R. T. Prater, plt engr.

• Olmulgee, Okla 160-3
PO Box 2351, Okmulgee; ph 2866.
Crude oper cap 19,000.
Fuel proc units—TCC cat crack 7000 fresh & 3000 recycle, cat poly prod 700.
Key personnel—L. W. Vautrain, supt; M. L. Porter, asst supt; H. I. Nelson, opers supt.

• Phillips, Texas 160-4
PO Box 271, Borger, Tex; ph BR 3-2831.
Crude oper cap 71,000.
Fuel proc units—fluid cat crack 38,000 fresh & 2000 recycle, Platformer 16,000, hydrodesulf 10,000, HF alky prod 8500, Cycloversion 11,000.
Key personnel—G. E. McKenna, supt; K. A. Anderson, asst supt; L. Riggins, chf plt engr.

• Sweeny, Texas 160-5
PO Box 308, Sweeny; ph Sweeny 33.
Crude oper cap 95,000.
Fuel proc units—fluid cat crack 24,000 fresh & 6000 recycle, Platformer 16,000, HF alky prod 5000.
Key personnel—G. A. Ibach, supt; J. B. Anderson, mfg supt; W. L. Houston, chf proc eng.

• Woods Cross, Utah 160-6
ph AX 5-2311.
Crude oper cap 12,500.
Fuel proc units—TCC cat crack 5500 fresh & 4500 recycle, cat poly prod 400.
Key personnel—A. A. Hale, supt; A. R. Yeates, opers supt.

PHOENIX REFINING CO* 161
133 Lotus (Box 1358), San Antonio, Tex; ph Lehigh 4-8828. R. R. Russel, Pres.

• San Antonio, Texas 161-1
Crude oper cap 3500.

PILOT OIL CO 162
Box 602, Lander 1, Wyo; ph 110.

• Morton, Wyo* 162-1
PO Box 11.
Crude oper cap 250 skimming.

PLYMOUTH OIL CO 163
Benedum-Trees Bldg, Pittsburgh 22, Pa; ph COurt 1-4137. R. L. Wentworth, VP.

• Texas City, Texas 163-1
Box 1191, Texas City; ph 5-2331. (Formerly Republic Oil Refining Co, merged into parent, Plymouth Oil Co, Apr-57.)*
Crude oper cap 38,100 oper, 8400 idle.
Prin prods—mtr gaso 15,750, jet fuels 1800, htg oils 7650, fuel oils 9530, rfy gas liqs 3400.
Fuel proc units—fluid cat crack 14,300 fresh & 3200 recycle, Platformer 6800; UOP poly prod 860.
Key personnel—L. W. Robbie, VP & genl mgr; M. E. Houser, plt supt.

PONTIAC EASTERN CORP* 164
3400 Lawrence Dr, Corpus Christi (PO Box

Pontiac Eastern Corp (cont)
1581), Tex; ph TUlip 2-8871. Affil of Pontiac Refining Corp.

• **Hattiesburg, Miss**—building.....164-1
has ODM FTA approval of $18.1-million, issued '56.
Crude oper cap 11,000.

PONTIAC REFINING CORP*.....165
3400 Lawrence Dr, Corpus Christi (PO Box 1581), Tex; ph TUlip 2-8871. E. Singer, Pres & Secy. Affil of Pontiac Eastern Corp.

• **Corpus Christi, Texas**.....165-1
Crude oper cap 44,600.

PREMIER OIL REFINING CO OF TEXAS....166
PO Box 1512, Longview, Tex; ph PL 9-4431. E. A. Heike, genl supt. Parent, City Products Corp.

• **Arp, Texas***.....166-1
refinery sold, being dismantled.

• **Baird, Texas**.....166-2
7 mi E of Baird off US Hwy 80; PO Box 1088, Baird; ph R 14.
Crude oper cap 2270.
Prin prods—mtr gaso 1050, jet fuels 400, htg oils 200, fuel oils 550.
Fuel proc units—therm crack 1200 fresh & 1800 recycle.
Key personnel—J. E. Bullock, odm supt; E. Dunlap, rfy supt.

• **Ft. Worth, Texas**.....166-3
NE 28 St (PO Box 15081, Fort Worth; ph TErminal 8-2346.
Crude oper cap 7870.
Prin prods—mtr gaso 4830, jet fuels 110, htg oils 990, fuel oils 610, rfy gas liqs 150.
Fuel proc units—UOP fluid cat crack 3000 fresh & 1500 recycle, Dubbs therm crack 2000 fresh & 6000 recycle, Platformer 1600, UOP cat poly prod 300.
Key personnel—L. B. Connelley, rfy supt; P. W. Morgan, asst rfy supt.

• **Longview, Texas**.....166-4
4 mi W of Longview off Hwy 80; PO Box 1512, Longview; ph PLaza 9-4431.
Crude oper cap 3780.
Prin prods—mtr gaso 1980, htg oils 540, fuel oils 1000.
Fuel proc units—therm crack 2200 fresh & 3800 recycle, Platformer 1500, UOP cat poly prod 70.
Key personnel—J. Courtney, rfy supt; G. T. Baylis, asst rfy supt.
Constr plans—1500 UOP Unifiner by Procon, onstream June-57.

PRIME OIL CO*.....167
division of Wood River Oil & Refining Co, Inc.

• **Calumet City, Ill**—planned.....167-1
to cost $10-million, announced 1954.
Crude oper cap 15,000.

PROVEN OIL & REFINING CO*.....168
see Thunderbird Corp & Arizona Refineries, Inc for similar plans. L. M. Glasco (West Coast Pipe Line Co), Pres.

• **Florence, Ariz**—planned.....168-1
ODM FTA approval for $18-million, issued 1952.
Crude oper cap 15,000.
Constr plans—engineered by Ebasco.

PURE OIL CO, THE.....169
35 E Wacker Dr, Chicago 1, Ill; ph STate 2-2100. A. F. Spiehler, mgr, rfy tech dept. Subsid, American Mineral Spirits Co.

• **Lemont, Ill**.....169-1
Box 239, Lemont. (Formerly Globe Oil & Rfg Co refinery.)*
Crude oper cap 48,000.
Fuel proc units—fluid cat crack 25,000 total, therm crack 2700, therm reform 5400, cat poly prod 1800, HF alky prod 1600.
Key personnel—J. M. Lawson, genl supt.
Constr plans—17,000 Kellogg hydrotreat for SR gaso & reformer feed, onstream fall-57; 12,000 SBK cat reform by Kellogg, onstream fall-57.

• **Newark, Ohio** (Heath Rfy).....169-2
Box 951, Newark.
Crude oper cap 17,500.
Fuel proc units—fluid cat crack 4500 total, SBK cat reform 2700, Kellogg hydrotreat 2700, therm crack 6500, UOP cat poly prod 400.
Key presonnel—D. P. Hankins, mgr.

• **Toledo, Ohio**.....169-3
Box 1798, Toledo.
Crude oper cap 31,000 oper, 7400 idle.
Fuel proc units—fluid cat crack 11,600 total, fixed-bed hydroform 4500, delayed coking 6300, therm crack 5850, UOP cat poly prod 1140.
Key personnel—H. H. Dronberger, mgr.

• **Nederland, Texas** (Smiths Bluff Rfy) 169-4
Box 237, Nederland.
Crude oper cap 78,900.
Fuel proc units—fluid cat crack 17,750 total, TCC cat crack 9800 total, therm crack 10,500 total, Ultraformer 13,500, Parsons hydrotreat 18,000, UOP cat poly prod 825, sulf acid alky prod 2550.
Key personnel—C. W. Cooper, mgr.

Q

QUAKER STATE OIL REFINING CORP.....170
Oil City, Pa; ph 6-1281. E. E. Ebner, VP-mfg, Emlenton, Pa; ph 351.

•**Emlenton, Pa**.....170-1
Ph 351.
Crude oper cap 2540.
Prin prods—mtr gaso 1067, htg oils 356, fuel oils 152, lube oil 635, waxes 20 t/cd.
Fuel proc units—Dubbs therm crack 635 fresh & 2223 recycle, Platformer 847, Dubbs therm reform 508 fresh & 508 recycle, UOP poly prod 63.
Key personnel—T. F. Parks, rfy supt; C. C. Jackson, asst supt.

• **Farmers Valley, Pa** (McKean Plt).....170-2
ph Rew 711.
Crude oper cap 3810.
Prin prods—mtr gaso 1600, htg oils 523, fuel oils 229, lube oil 953, waxes 20 t/cd.
Fuel proc units—Dubbs therm crack 1143 fresh & 4000 recycle, Platformer 1270, UOP poly prod 85.
Key personnel—N. W. Hill, rfy mgr; E. T. Coleman, rfy supt.

• **St Marys, W. Va**.....170-3
Crude oper cap 2371.
Prin prods—mtr gaso 996, htg oils 332, fuel oils 142, lube oil 593, waxes 5 t/cd.
Fuel proc units—Dubbs therm crack 635 fresh & 2223 recycle, Platformer 847, Dubbs therm reform 1016 fresh & 508 recycle, UOP poly prod 63.
Key personnel—T. A. Anderson, rfy mgr; E. Weber, opers supt.

QUEEN CITY OIL & REFINING CO*.....171
Dickenson, ND. Reorganized 1956.

• **Dickenson, ND**.....171-1
Crude oper cap 4500.

R

R. J. OIL & REFINING CO, INC.....172
111 N 7th St, Terre Haute, Ind; ph Crawford 6041. E. A. Johnson, Treas.

• **Princeton, Ind**.....172-1
3 mi So of Princeton, on Hwy 41; Box 16, Princeton; ph Fulton 5-4821.
Crude oper cap 4400.
Prin prods—mtr gaso 1760, htg oils 1364, fuel oils 1012.
Fuel proc units—UOP Dubbs therm crack 1800 fresh & 4000 recycle, Platformer 750.
Key personnel—R. L. Hoelscher, rfy mgr; T. C. Stallings, rfy supt.
Constr plans—1700 Unifiner-Platformer under study.

RADO REFINING CO.....173
Box 71, McAllen, Tex; ph MU 6-4337. J. Holland, Pres; C. R. Mitchell, Secy.

• **McAllen, Tex**.....173-1
2½ mi W of McAllen on US 83; mail & ph as above.
Crude oper cap 1500 oper, 300 idle.
Prin prods—mtr gaso 600, htg oils 600, fuel oils 60.
Fuel proc unit—skimming 1550.
Key personnel—C. J. Holland, Pres (rfy mgr); H. A. Wolfshohl, opers supt.

REISCHMANN REFINERY, R. J.*.....174
Ft Stockton, Tex; ph 152.

• **Ft Stockton, Texas**.....174-1

REPUBLIC OIL & REFINING CO*
became refining & marketing division of parent, Plymouth Oil Co, by merger Apr-57.

REX OIL REFINING CO*.....175
Box 1526, Rapid City, SD. G. M. Lewis, Pres & treas.

• **Rapid City, SD**—shutdown.....175-1
Crude oper cap (when oper) 200.

RHODE ISLAND REFINING CORP*.....176
75 Bridgewater St, Brooklyn, NY. Formerly Paragon Refining Co. Parent, Paragon Oil Co.

• **Tiverton, RI**—planned.....177-1

RICHARDSON REFINING CO, SID.....177
Fort Worth, Tex; ph Edison 5-4591. F. W. Bradford, genl mgr.

• **Texas City, Texas**—idle.....177-1
in city on S Hwy 146; PO Box 251, Texas City; ph 5-2381.
Crude oper cap 16,000 idle.
Fuel proc units—therm crack 8000, Petreco desulf 4000. Now operating as liquid bulk storage and terminal.
Key personnel—E. W. Fisher, rfy mgr.

RICHFIELD OIL CORP.....178
555 S Flower St, Los Angeles 17, Calif; ph MAdison 9-4111.

• **Wilmington, Calif** (Watson Rfy).....178-1
4 mi NE of Wilmington, NW corner Sepulveda & Alameda Sts; Box 787, Wilmington; ph Terminal 4-2521.
Crude oper cap 129,500.
Fuel proc units—TCC cat crack 21,000 fresh & 7000 recycle, fluid cat crack 33,500 fresh & 25,500 recycle, therm crack 21,000 fresh & 24,000 recycle, Sinclair-Baker cat reform 16,000, Sinclair hydrotreaters 16,000 & 7500, butane isom 900 fresh & 1300 recycle, visbreak of asphalt 27,000 fresh & 18,000 recycle, UOP poly prod 1800, butylene alky prod 6500.
Key personnel—C. R. McKay, mgr rfys; R. P. Corlew, asst mgr rfys; E. H. Reynolds, supt opers; F. J. Fontana, chf engr; B. W. Neumaier, chf proc engr.

• **Puget Sound, Wash***.....178-2
has 1000 acres NW of Everett, Wash, for refinery site.

ROCK ISLAND REFINING CORP.....179
PO Box 6091, Indianapolis 20, Ind; ph TRinity 8-2373. L. E. Kincannon, VP & genl mgr.

• **Indianapolis, Ind**.....179-1
12 mi NW of downtown Indianapolis on Indiana Rd 100; mail & ph as above.
Crude oper cap 14,200.
Prin prods—mtr gaso 7100, jet fuels 700, htg oils 3600, fuel oils 2000.
Fuel proc units—UOP fluid cat crack 6000 fresh & 1500 recycle, Platformer 2400, Unifiner 460, UOP cat poly prod 410.
Key personnel—L. E. Kincannon, VP (rfy mgr); C. O. Anerson, rfy supt.
Constr plans—5000 UOP Unifiner by staff, onstream Aug-57.

ROTHSCHILD OIL CO*.....180
12354 E Lakeland Rd, Santa Fe Springs, Calif; ph RA 3-3357.

• **Santa Fe Springs, Calif**.....180-1
Crude oper cap 9000.

S

SALT LAKE REFINING CO.....181
Box 1889, Salt Lake City 10, Utah; ph Elgin 9-7751. Parent, Standard Oil Co (Calif).

• **Salt Lake City, Utah**.....181-1
2351 N 10th W, Salt Lake City; mail & ph as above.
Crude oper cap 38,000.
Prin prods—variable mtr gaso, avgas, jet fuels, htg oils, fuel oils, rfy gas liqs.
Fuel proc units—Houdriflow cat crack 9000 fresh & 2700 recycle, Esso Model IV cat crack 4000 fresh & 4000 recycle.
Key personnel—M. H. Pramme, mgr; A. B. Chinn, supt of opers; R. W. Ayer, chf engr.
Constr plans—6000 platformer by Fluor, onstream Nov-57; crude unit to add 3000 to present unit, by staff, compl Jul-57.

SALYER REFINING CO, INC*.....182
2400 NE 4th St (Box 6115), Oklahoma City, Okla; ph Forest 5-1328.

• **Oklahoma City, Okla**.....182-1
2201 NE 2nd St, Oklahoma City 11, Okla.
Crude oper cap 2000.

SEARLE PETROLEUM CO*.....183
1126 N 11th St, Omaha 2, Nebr; ph We 2330. H. A. Searle, Jr, Pres & genl mgr.

• **Omaha, Nebr**—shutdown.....183-1
Crude oper cap (when oper) 2000 skimming.

• **Salem, Nebr**.....183-2
Crude oper cap 1000 skimming.

SEASIDE OIL CO.....184
330 State St, Santa Barbara, Calif; ph WOodland 5-4501. G. C. Howell, secy. Parent, Tidewater Oil Co.

• **Ventura, Calif**.....184-1
Olive St, ½ mi N of city limits; PO Box 1130

entura; ph Miller 3-2216.
Crude oper cap 4400.
Prin prods—mtr gaso 800, jet fuels 700, htg ils 600, fuel oils 1850, rfy gas liqs 35, asphalt 50.
Key personnel—L. E. McCampbell, rfy supt; D. E. Searles, asst supt.
Constr plans—considering Union Hyperform- er for some time after 1957.

SEMINOLE ASPHALT & REFINING LTD*....185
PO Box 4, St Marks, Fla. 50% ownel by Lincoln Gas & Refining Co.

• **St Marks, Fla....185-1**
Crude oper cap 2000.

SHAMROCK OIL & GAS CORP, THE....186
PO Box 631, Amarillo, Tex; ph DRake 3-7411.

• **Sunray, Texas** (McKee Rfy)....**186-1**
8 mi NE of Dumas, on Hwy 119 to Sunray; mail Sunray; ph Webster 5-2141 (Dumas).
Crude oper cap 16,500.
Prin prods—mtr gaso 9950, avgas 2200, jet fuels 2450, other fuels 5000, fuel oils 300.
Fuel proc units—Houdriflow cat crack 10,000 fresh & 3000 recycle; UOP therm crack 3000 fresh & 9000 recycle; Platformer 4000, Unifiner 5000, Kellogg sulf acid alky prods 2200.
Key personnel—A. V. Beckworth, supt of plts; W. L. Ledgerwood, asst supt of plts; G. Wherry, chf engr; D. Bird, chf proc engr.
Constr plans—2000 Phillips n-butane isom & 1500 Phillips isobutane crack, by Leonard Constr Co, for late-57 comp; 75 t/d Monsanto acid sludge regen & contact sulf acid plt by Leonard Constr Co, for early-58 compl.

SHAMROCK OIL & REFINING CO*....187
Box 966, Saginaw, Mich.

• **Saginaw, Mich**—shutdown....**187-1**
Crude oper cap (when oper) 3500.

SHELL OIL CO....188
50 W 50th St, New York 20, NY; ph JUdson 6-5000. Affil, Shell Oil Co of Canada, Ltd.

• **Martinez, Calif....188-1**
at city on Carquinez Strait, about 20 mi NE of San Francisco; Box 711, Martinez.
Crude oper cap 47,300 oper, 7700 idle.
Prin prods—mtr gaso 14,400, htg oils 9700, fuel oils 17,100, lube oil 3100, C_3 rfy gas liqs 450, greases 50.
Fuel proc units—Dubbs therm crack 31,300 total, Platformer 5500.
Key personnel—B. Stolley, rfy mgr; J. B. Dunlap, rfy supt; J. B. St. Clair, asst supt.

• **Wilmington (Dominguez), Calif....188-2**
Los Angeles area; Box 728, Wilmington; ph TErminal 5-5611.
Crude oper cap 72,800 oper, 6200 idle.
Prin prods—mtr gaso 28,800, avgas 7300, jet fuels 2400, htg oils 9700, fuel oils 23,600, C_3 rfy gas liqs 1800.
Fuel proc units—fluid cat crack 24,000 total, Dubbs therm crack 34,150 total, dehydrog 3800, Shell hydrodesulf 12,000, liq-phase (C_4) isom 2800, sulf acid alky prod 5500.
Key personnel—P. J. Merkus, rfy mgr; G. C. Montgomery, rfy supt; J. M. Wilson, asst supt.

• **Wood River, Ill....188-3**
2½ mi SE of city; PO Box 262; ph Wood River 4-7371.
Crude oper cap 162,000 oper, 13,000 idle.
Prin prods—mtr gaso 76,900, avgas 13,000, jet fuels 700, htg oils 43,000, fuel oils 43,000, lube oil 3100, C_3 rfy gas liqs 1800, coke 3200.
Fuel proc units—fluid cat crack (2 units) 55,000 fresh & 21,000 recycle, Dubbs therm crack 15,500 total, Platformer (2 units) 36,000, Dubbs therm reform (2 units) 20,000 hydro-desulf 20,000, CDU hydrogen treat 11,000, Shell Liq-Phase isom 2350, Dubbs coker 14,000, UOP cat poly prod 1200, sulf acid alky prod (3 units) 9000.
Key personnel—H. D. Dale, rfy mgr; G. C. Cunningham, supt opers.

• **Norco, La....188-4**
25 mi upstream from New Orleans on Mississippi River; mail at Norco; ph Norco 2141.
Crude oper cap 89,000 oper, 6000 idle.
Prin prods—mtr gaso 43,300, avgas 7100, htg oils 30,000, fuel oils 8400, C_3 rfy gas liqs 1200.
Fuel proc units—fluid cat crack 58,000 fresh & 1000 recycle, Dubbs therm crack 9000 total, Dubbs therm reform (2 units) 9000 total, UOP cat poly prod 1300, sulf acid alky prod (2 units) 7000.
Key personnel—R. W. Faulk, rfy mgr; R. S. Douglas, supt; J. D. Davis, asst supt.

• **Houston, Texas....188-5**
15 mi SE of city on Ship Channel at Deer Park; Box 2527, Houston 1; ph GReenwood 9-2311.
Crude oper cap 124,200 oper, 800 idle.
Prin prods—mtr gaso 43,600, avgas 9400, jet fuels 800, htg oils 31,200, resid fuel oils 19,100, lube oil 3600, waxes 1000.
Fuel proc units—fluid cat crack 37,000 fresh & 1500 recycle, Dubbs therm crack (3 units) 31,000 total, Platformer (2 units) 31,000, Dubbs therm reform 14,000 total, Shell hydrodesulf 16,000, sulf and alky prod 4600.
Key personnel—J. A. Tench, rfy mgr; L. J. Snyder, asst supt; M. A. Rogers, asst supt.

• **Anacortes, Wash....188-6**
on Puget Sound, 65 mi N of Seattle, Wash; Box 700 Anacortes; ph CYpress 3-9111.
Crude oper cap 25,600 oper (low because of strike), 24,400 idle.
Prin prods—mtr gaso 15,300, htg oils 4900, fuel oils 3800, C_3 & C_4 rfy gas liqs 300.
Fuel proc units—2-stage fluid cat crack 22,000 total, Platformer 8000, hydrodesulf 8000, UOP cat poly prod (2 units) 3800.
Key personnel—R. C. Barton, rfy mgr; J. B. Wyman, rfy supt; H. S. Hicks, asst supt.

SHERWOOD REFINING CO, INC*....189
now Sherwood Refining Div of Continental Oil Co. Refineries at Gretna, La, & Karns City, Pa, (not reported by Continental).

SINCLAIR REFINING CO*....190
600—5th Ave, New York 20, NY; ph Circle 6-3600.

• **Hartford, Ill*....190-1**
Crude oper cap 29,000.

• **East Chicago Ind*....190-2**
Crude oper cap 111,000.

• **Wellsville, NY*....190-3**
Crude oper cap 8000.

• **Marcus Hook, Pa*....190-4**
Crude oper cap 114,000.

• **Corpus Christi, Texas*....190-5**
Crude oper cap 29,000.

• **Houston, Texas*....190-6**
Crude oper cap 138,000.

• **Sinclair, Wyo*....190-7**
Crude oper cap 24,000.

SIOUX OIL CO....191
Box 811, Newcastle, Wyo; ph Sherwood 6-4445.

• **Chadron, Nebr** (dismantled)....**191-1**

• **Newcastle, Wyo....191-2**
adjacent to Newcastle on W; mail & ph as above.
Crude oper cap 3200.
Prin prods—mtr gaso 1376, jet fuel 576, htg oils 480, fuel oils 640, rfy gas liqs 100.
Fuel proc units—therm crack 1800, Houdriformer 750, poly prod 50.
Key personnel—L. Martin, rfy supt; G. Jackson, asst supt.
Constr plans—2 MMCFD LPG unit by staff, onstream Jun-57.

• **Newcastle, Wyo**—idle....**191-3**
mail & ph as above.
Crude oper cap (when oper) 1500.

SKELLY OIL CO....192
Box 1650, Tulsa, Okla; ph CHerry 2-2131.

• **Adams City, Colo** (Denver Rfy)....**192-1**
Box 308, Adams City; ph Atlas 8-0751.
Crude oper cap 1400.
Fuel proc units—therm crack 750, Platformer 600.
Key personnel—H. B. Masters, rfy supt.

• **El Dorado, Kans....192-2**
1401 Douglas Rd (Box 1121) El Dorado, Kans; ph 2480.
Crude oper cap 42,000.
Fuel proc units—fluid cat cracker 19,000 fresh & 2500 recycle, therm crack 10,000, Platformer 7000, Kellogg poly prod 1300.
Key personnel—J. O'Reilly, rfy supt; R. L. Creager, asst rfy supt; W. I. Pursell, chf engr.
Constr plans—3500 Phillips HF Alky, onstream spring-58.

• **Longview, Texas....192-3**
2072 E Cotton St, Longview; ph Plaza 8-2716.
Crude oper cap 4500.
Fuel proc units—therm crack 3200, Platformer 1600, UOP poly prod 90.
Key personnel—J. D. Waddell, rfy supt.

SOCAL OIL & REFINING CO....193
Box 430, Huntington Beach, Calif; ph LExington 6-4504. J. H. Grimes, Pres.

• **Huntington Beach, Calif....193-1**
18971 Main St.
Crude oper cap 2500.
Prin prods—mtr gaso 750, htg oils 500, fuel oils 1250, liq asphalt 30 t/cd.
Fuel proc unit—UOP Dubbs therm crack 1700.
Key personnel—E. S. Tayloe, supt.

SOCONY MOBIL OIL CO, INC....194
150 E 32nd St, New York 17; ph OXford 7-4200. (formerly Socony-Vacuum Oil Co. Inc.)* Subsids, General Petroleum Corp, Magnolia Petroleum Co.

• **East St Louis, Ill....194-1**
S 20th St, E St Louis;
Crude oper cap 38,000.
Prod—coke 275 t/cd.
Fuel proc units—TCC cat crack 20,860 fresh & 8,940 recycle, cat reform 10,800, delayed coking 9500, cat poly prod 600, HF alky prod 2400.
Key personnel—H. A. Lutz, mgr; D. A. Hermanson, asst mgr; G. T. Snyder, mgr tech div; L. J. Keenan, chf engr.

• **East Chicago, Ind....194-2**
Crude oper cap 36,000.
Fuel proc units—Kellogg comb therm crack 6800, TCC cat crack 14,580 fresh & 1620 recycle, cat reform 8100 H_2SO_4 alky prol 2900.
Key personnel—W. W. Reed, mgr; W. B. Kleihege, asst mgr; L. L. Claassen, chf eng; J. A. Hart, tech dir; J. W. Mann, operg supt.

• **Augusta, Kans....194-3**
Crude oper cap 35,000.
Prod—asphalt 6400.
Fuel proc units—TCC cat crack 13,455 fresh & 7245 recycle; therm crack 4200, cat reform 2700, HF alky prod 1300.
Key personnel—J. W. Glass, mgr; H. L. Bedell, supt operg dept; M. Morrison, engrg. supt.
Constr plans—8100 cat reform by Pritchard, onstream Aug-57.

• **Trenton, Mich....194-4**
Crude oper cap 29,500.
Prod—coke 180 /tcd.
Fuel proc units—TCC cat crack 13,455 fresh & 7,245 recycle, delayed coking 5500, cat poly prod 800.
Key personnel—T. S. Lennox, mgr; E. A. Wilson, chf engr; C. A. Windberg, refy supt.
Constr plans—3200 H_2SO_4 alky by Fluor, onstream Dec-57.

• **Paulsboro, NJ....194-5**
Crude oper cap 80,000.
Prods—asphalt 1050, lube oils 7500.
Fuel proc units—TCC cat crack 23,625 fresh & 7875 recycle, cat reform 18,000, HF alky prod 1800.
Key personnel—L. E. Cranston, mgr; S. W. Thomson, asst mgr; R. Lee, tech dir; H. D. Chapman, supt operg dept.
Constr plans—20,000 cat hydrodesulf by Foster Wheeler, onstream July-57.

• **Brooklyn, NY....194-6**
400 Kingsland Ave, Brooklyn 22, NY.
Crude oper cap 25,000.
Fuel proc units—TCC cat crack 9315 fresh & 11,385 recycle, cat poly prod 1100.
Key personnel—D. P. Parker mgr; E. F. Pinney, asst mgr; K. M. Urquhart, supt proc dept; F. R. Gohlke, mgr genl engrg dept.

• **Buffalo, NY....194-7**
Box 367, Buffalo 5, NY.
Crude oper cap 26,000.
Prod—asphalt 2050.
Fuel proc units—TCC cat crack 10,530 fresh & 5670 recycle, cat reform 8100, cat poly prod 900.
Key personnel—T. C. Lockhart, mgr; H. P. Shephard, asst mgr; F. D. Higby, operg supt; C. H. DuBois, tech dir.
Constr plans—2600 H_2SO_4 alky by Kellogg, onstream Sept-57.

• **East Providence, RI....194-8**
Prod—asphalt 4000.
Key personnel—H. P. Caldwell, mgr; A. H. Cole, operg supt; A. H. Fuller, tech supt.

• **Casper, Wyo....194-9**
Crude oper cap 11,500.
Prod—asphalt 1350.
Fuel proc units—TCC cat crack 3500 fresh & 3500 recycle, therm crack 1200, cat poly prod 400.
Key personnel—E. T. Pummill, mgr; C. A. Goodnight, operg supt; C. L. Allison, tech dir.
Constr plans—2900 cat reform by Pritchard, onstream Nov-57; 2700 hydrodesulf by Pritchard, onstream Nov-57.

SOHIO PETROLEUM CO
see Standard Oil Co (Ohio) Covington, Ky. refinery.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

■ 1957 Refinery Directory

SOL-TEX REFINING CO* 195
Fairfield, Ill.

• **Fairfield, Ill**—shutdown 195-1
Crude oper cap (when oper) 2500.

SOLAR OIL & REFINING CO 196
217 Hedden Bldg, Billings, Mont; ph 6-6766. J. Wight, Pres.

• **Big Horn Count, Mont**—shutdown 196-1
approx 50 mi SW of Hardin, Mont; mail & ph as above.
Crude oper cap (when oper) 800.
Prin prods—mtr gaso, jet fuels, htg oils, fuel oils.

SONNEBORN & SONS, INC, L 197
300 Fourth Ave, New York 10, NY; ph Oregon 3-6000.

• **Franklin, Pa** (Franklin Rfy) 197-1
N of Franklin.
Crude oper cap 1500.
Prin prods—htg oils 400, lube oils 400, greases 100, waxes 100.
Key personnel—L. C. Borell, mgr; G. Coulter, proc supt.

• **Petrolia, Pa** (Daugherty Rfy) 197-2
S of city; ph Butler 2-9970.
Feedstock, petroleum fractions.
Prin prods—waxes 200, coke 30.
Key personnel—H. Schindler, mgr; G. A. Kessler, proc supt; M. Blumer, proc supt; A. W. Straube, chf engr.
Constr plans—modification of percolation filtration plant, to be compl 11-57.

SOUTH PENN OIL CO* 198
Drake Bldg, 106 Duncomb St, Oil City (Box 781, Pa; ph 4-1281. Subsid, Elk Refining Co.

• **Rouseville, Pa** (Pennzoil Div) 198-1
Rouseville, Pa; ph 6-1231.
Crude oper cap 10,000 oper, 3000 idle.

SOUTHERN OIL SERVICE* 199
63 Hart St, Nashville (Box 147), Tenn, E. C. Pellettieri, Pres.

• **Nashville, Tenn** 199-1
Crude oper cap 700 skimming.

SOUTHLAND CO, THE* 200
Southland Bldg, Yazoo City (Box 57), Miss; ph 1212. E. Constantin, Jr, Pres & mgr. Subsid, Delta Refining Co.

• **Tampa, Fla**—planned 200-1
Crude oper cap 15,000.

• **Sandersville, Miss** 200-2
Box 128, Sandersville.
Crude oper cap 4500 skimming.

SOUTHWESTERN OIL & REFINING CO* 201
Port & Summers Sts (Drawer 809), Corpus Christi, Tex; ph TUlip 4-8863. S. S. Seltzer, Jr, Pres & genl mgr.

• **Corpus Christi, Texas (Plt No 1)** 201-1
Coke & Nueces Sts, Corpus Christi, Tex.
Crude oper cap 15,000.

• **Corpus Christi, Texas** (Plt No 2) 201-2
Nueces Bay Blvd, Corpus Christi, Tex.
Crude oper cap 30,000.

STANDARD OIL CO (CALIF)* 202
225 Bush St, San Francisco 20, Calif; ph SUtter 1-7700. Subsids, Standard Oil Co (Calif), Western Operations, Inc; American Bitumuls & Asphalt Co; Salt Lake Refining Co; Standard Oil Co (Texas); California Oil Co; Standard Oil Co of British Columbia Ltd. Part owner of American Gilsonite Co.

STANDARD OIL CO OF CALIF, WESTERN OPERATIONS, INC 202
225 Bush St, San Francisco, Calif; ph Sutter 1-7700. G. M. Foster, Secy. (Formed late 1956 to manage petroleum operations in West for parent, Standard Oil Co of Calif)*

• **Bakersfield, Calif** 202-1
PO Box 1500, Bakersfield, Calif; ph Export 9-1741.
Crude oper cap 20,000.
Fuel proc units—therm crack 9000.
Key personnel—L. L. Henning, rfy mgr.

• **El Segundo, Calif** 202-2
PO Box 97, El Segundo, Calif; ph Eastgate 2-3450.
Crude oper cap 122,000.
Fuel proc units—fluid cat crack 36,000, therm crack 59,000. Platformer 30,000, therm reform 11,000, Unifiner 20,000, H_2SO_4 alky prod 5400.
Key personnel—D. K. Harger, rfy genl mgr; C. D. Lewis, mgr-opers; H. C. Ashley, chf engr.
Constr plans—20,000 residuum stripper by Fluor, onstream 4-Q-57; 12,000 crude dist under constr for 1957 compl.

• **Richmond, Calif** 202-3
PO Box 1272, Richmond; ph Beacon 2-1514.
Crude oper cap 165,000 (incl 25,000 to vac dist for crack feed).
Fuel proc units—TCC cat crack 32,000, therm crack 50,000, Unifiner-Platformer 20,000, Hydroformer (own design) 12,500, visbreak 7500, HF alky prod 4000.
Key personnel—C. W. Rehfuss, rfy genl mgr; M. F. Miller, rfy asst genl mgr; T. M. Sheehy, mgr-opers; A. S. Guerard, chf engr.
Constr plans—38,000 crude dist, under constr for 1957 compl.

• **Everett, Wash*** 202-4
Crude oper cap 60,000.
Constr plans—to cost $75-million with compl sched late-57.

STANDARD OIL CO (IND) 203
910 S Michigan Ave, Chicago 80, Ill; ph Harrison 7-9200. Subsids, Utah Oil Refining Co; The American Oil Co.

• **Wood River, Ill** 203-1
Crude oper cap 50,000.
Fuel proc units—fluid cat crack 19,000 total, therm crack 10,200 total, Ultraformer 9000, therm reform 7060, hydrodesulf 15,000 b/sd, visbreak 3400, batch coke 3740, cat poly prod 123, sulf acid aviation alky prod 3400.
Key personnel—L. H. Butterworth, rfy mgr; S. E. Cahoon, assts mgr; R. A. Jack, asst mgr; J. K. Roedel, chf engr.

• **Whiting, Ind** 203-2
2700 New York Ave, Whiting, Ind; ph 2700.
Crude oper cap 209,000.
Fuel proc units—fluid cat crack 60,000 total, therm crack 42,000 total, (several processes), Fixed-Bed Hydroformer 14,000, Ultraformer 14,000, therm reform 15,300 total, (several processes), delayed coker 41,000, visbreak 14,000, cat poly prod 10, sulf acid aviation prod 5000.
Key personnel—A. F. Endres, rfy mgr; A. H. Hayes, asst mgr; P. L. Krauel, chf engr.
Constr plans—21,000 b/sd Ultraformer by Parsons, onstream early-57; 21,000 b/sd Ultraformer by McKee, onstream '58.

• **Neodesha, Kans** 203-3
on Fall River; PO Box 120.
Crude oper cap 22,500.
Fuel proc units—fluid cat crack 10,000 total, batch coke 5100, sulf acid aviation alky prod 1000.
Key personnel—P. C. Livesay, rfy mgr; H. G. Schnetzler, asst mgr; C. J. Sines, chf engr.
Constr plans—6000 b/sd Ultraformer by Foster Wheeler, for 1958 compl.

• **Sugar Creek, Mo** 203-4
junction of Sugar Creek & Missouri River.
Crude oper cap 74,300.
Fuel proc units—fluid cat crack 32,000 total, therm crack 19,600 total, Ultraformer 14,000, therm reform 6,000, hydrodesulf 20,000, batch coke 5500, delayed coker 24,900 b/sd, cat poly prod 1800.
Key personnel—H. R. Baehmer, rfy mgr; I. C. Staeuble, asst mgr; G. W. Larson, chf engr.
Constr plans—3800 b/sd alky unit by Foster Wheeler, for mid-57.

• **Mandan, ND** 203-5
2 mi N of Mandan, on Missouri River.
Crude oper cap 31,600.
Fuel proc units—fluid cat crack 23,000 total, Ultraformer 1000, cat poly prod 4365.
Key personnel—T. E. Stockdale, rfy mgr; R. N. Giles, asst mgr; L. H. Huth, supt-operg div; W. G. Roesch, chf engr.

• **Casper, Wyo** 203-6
on North Platte River; PO Box 160.
Crude oper cap 18,600.
Fuel proc units—fluid cat crack 8650 total, therm crack 4450 total, Ultraformer 3750, batch coke 2500, sulf acid aviation alky prod 800.
Key personnel—Dr. C. C. Buchler, rfy mgr; N. T. Robey, asst mgr; J. W. Yant, chf engr.
Constr plans—4800 b/sd vac pipe still, 1000 b/sd propane deasphalt, 1500 b/sd furfural extr, 2000 b/sd MEK dewaxing & deoiling, by Foster Wheeler for mid-57 compl.

STANDARD OIL CO (NJ)* 204
30 Rockefeller Plaza, New York 20, NY; ph PLaza 7-3000. Subsids, Carter Oil Co, Esso Standard Oil Co, Humble Oil & Refining (87%), Imperial Oil Ltd (70%).

STANDARD OIL CO (OHIO) 204
1707 Midland Bldg, Cleveland 15, Ohio; ph MAin 1-7400. H. G. Cannon, Jr, genl supv opers staff, mfg dept.

• **Covington, Ky** (Sohio Petroleum Co—Latonia Rfy) 204-1
PO Box 312.
Crude oper cap 16,000.
Prin prods—mtr gaso 2500, jet fuels 200, htg oils 3500, fuel oils 1500, asphalt 3000.
Fuel proc units—tube & tank therm crack 6000 fresh, tube & tank therm reform 4000 fresh, Kellogg poly prod 400.
Key personnel—R. Elo, mgr; D. W. Heil, genl supt; E. N. Richards, chf engr.

• **Cleveland, Ohio** (No 1 Rfy) 204-2
2735 Broadway, Cleveland 13; ph Dimond 1-0600.
Crude oper cap 52,000.
Prin prods—mtr gaso 27,000, htg oils 14,000, fuel oils 6,000, asphalt 5000.
Fuel proc units—TCC cat crack 20,000 fresh & 7000 recycle, tube & tank therm crack 9000 fresh, Ultraformer 10,000 Std Ind hydrodesulf 10,000, UOP cat poly prod 900.
Key personnel—J. S. Dalton, mgr; K. A. McDaniel, genl supt; N. C. Fuller, chf engr.
Constr plans—3100 Esso sulf acid alky by McKee, for mid-58 compl.

• **Cleveland, Ohio** (No 2 Rfy) 204-3
5703 Hamlet Ave, Cleveland 27.
Crude oper cap—none reported.
Prin prods—lube oil 1650, greases 8 t/cd, waxes 30 t/cd.
Key personnel—R. H. Laird, mgr; R. G. Atkinson, genl supt; J. F. Klicman, chf engr.

• **Lima, Ohio** 204-4
PO Drawer H, Lima.
Crude oper cap 47,000.
Prin prods—mtr gaso 29,000, htg oils 15,000, fuel oils 1500, lube oil 1800, rfy gas liqs 1600, coke 1500 t/cd.
Fuel proc units—fluid cat crack 27,000 fresh & 7000 recycle, Platformer 11,000, Unifiner 12,000, delayed coker 11,000, UOP cat poly prod 700.
Key personnel—S. R. Bolles, mgr; G. B. Pugh, genl supt; R. T. Roffee, chf engr.

• **Toledo, Ohio** 204-5
Cedar Point & Otter Creek Rd, Oregon Township; PO Box 696, Toledo 1.
Crude oper cap 23,000.
Prin prods—mtr gaso 7000, avgas 5500, jet fuels 1500, htg oils 4500, fuel oils 1500, rfy gas liqs 400, coke 500 t/cd.
Fuel proc units—Kellogg comb therm crack 5000 fresh, Kellogg comb. therm reform 5000 fresh, delayed coker 6500, UOP cat poly prod 600, sulph alky prod 4600.
Key personnel—I. L. Peterson, mgr; G. R. Thompson, genl supt; R. E. Hense, chf engr.
Constr plans—54,000 crude & vac dist, 6800 delayed coker, 20,000 hydrog, 11,000 SBK cat reformer, 27,000 UOP fluid cat crack, 1000 UOP cat poly, by Kellogg and for spring-58 compl.

STANDARD OIL CO OF TEXAS 205
PO Box 1249, Houston 1, Tex. M. P. Paret, Jr, VP, Parent, Standard Oil Co (Calif).

• **El Paso, Tex** 205-1
6501 Trowbridge St, 6 mi E of city center; PO Box 862, El Paso; ph Prospect 2-1411.
Crude oper cap 38,000.
Prin prods—mtr gaso 18,400, avgas 2000, jet fuels 2600, htg oils 11,000, fuel oils 3000, rfy gas liqs 600.
Fuel proc units—Houdriflow cat crack 10,000 fresh & 4000 recycle, Dubbs therm crack 7000, Platformer 5000, Kellogg sulf acid alky prod 1500.
Key personnel—J. H. Kitchen, mgr, rfy; E. C. Hurt, asst to mgr, rfy; J. E. Hayden, rfy engr; P. P. Mustain, opers supt.
Constr plans—25,000 two-stage crude unit by Fluor, onstream Feb-58; 24,500 Esso Model IV fluid crack by Fluor, onstream Feb-58; 1765 Calif poly by Fluor, onstream Feb-58.

STRAITS REFINING CO* 206
Puget Sound, Wash.

• **Puget Sound, Wash**—planned 206-1
Crude oper cap 10,000. ODM FTA approval for $26.4-million. Project handled by Kaiser.

SUN OIL CO 207
1608 Walnut St, Philadelphia 3, Pa; ph KIngsley 6-1600. Subsid, Sun Oil Co Ltd.

• **Toledo, Ohio** 207-1
Woodville Ave & Bay Terminal RR; PO Box 920, Toledo 1; ph Taylor 3561.
Crude oper cap 95,000.
Prin prods—mtr gaso, jet fuels, htg oils, fuel oils, rfy gas liqs.
Fuel proc units—cat crack 62,000, therm crack, Platformer 14,700, therm reform, sulf acid alky prod 1400.
Key personnel—J. F. Harron, mgr of rfy; H. C. Thober, supt of rfy; J. L. Barker, rfy engr.

Marcus Hook, Pa **207-2**
CHester 5-1121.
Crude oper cap 160,000.
Prin prods—mtr gaso, avgas, jet fuels, htg ... fuel oils, lube oil 11,800, rfy gas liqs, ...ases, waxes, coke, asphalt 800.
Fuel proc units—cat crack 76,000, therm ...ack, cat reform 32,000, therm reform 24,000, ...drogen treat, visbreak, poly unit, HF alky ...od 7000.
Key personnel—C. C. Naylor, mgr; W. C. ...uffman, supt rfg; F. W. Bowen, rfy engr.

SUNLAND REFINING CORP **208**
PO Box 1512, Fresno 16, Calif; ph AD 7-7148. G. A. Olson, Pres.

• **Bakersfield, Calif** **208-1**
Coffee Rd & Santa Fe; PO Box 1345, Bakersfield; ph Fairview 5-8615.
Crude oper cap 4500.
Prin prods—mtr gaso 1800, jet fuels 400, htg oils 700, fuel oils 1600.
Fuel proc unit—visbreak 1100.
Key personnel—W. E. Osburn, rfy supt.

SUNRAY MID-CONTINENT OIL CO* **209**
Sunray Bldg, Tulsa 2 (PO Box 20391, Okla; ph LU 7-6571. Formed by merger of Sunray Oil Co & Mid-Continent Petroleum Corp. Subsids, D-X Sunray Oil Co, Ucan Products Co (80%).

SUNSET INTERNATIONAL PETROLEUM CORP **209**
Box 2324 Terminal Annex (3450 Wilshire Blvd), Los Angeles 5, Calif; ph Dunkirk 5-3501. (Formed by merger of Sunset Oil Co & International Mining Corp in 1956.)*

• **Torrance, Calif** **209-1**
21000 S Figueroa St, Torrance; PO Box 518, Torrance; ph Nevada 6-5778.
Crude oper cap 5500 oper, 3500 idle.
Prin prods—mtr gaso 5500, jet fuels 800, htg oils 750, fuel oils 2000.
Fuel proc units—Dubbs therm crack 3200 fresh & 3600 recycle, cat poly prod 80.
Key personnel—C. C. Squire, mgr field opers; A. Jones, rfy supt; D. H. Austin, chf field engr.

SUNSHINE STATE REFINERIES, INC* **210**
Plant City, Fla.

• **Plant City, Fla**—planned **210-1**
ODM FTA approved. Handled by Kaiser.
Crude oper cap 10,000.

SUNTIDE REFINING CO **211**
PO Box 658, Corpus Christi, Tex; ph Tu 4-3851.

• **Corpus Christi, Texas** (Suntide Rfy) **211-1**
5 mi W of Corpus Christi on Shell Rd at Viola; mail & ph as above.
Crude oper cap 65,000.
Prin prods—mtr gaso 20,000, 115/145 avgas 2000, JP-4, jet fuels 7000, htg oils 30,000, fuel oils 6000, rfy gas liqs 300.
Fuel proc units—UOP fluid cat crack 18,500 fresh & 11,500 recycle, UOP tetramer prod 450, poly gaso prod 100, UOP HF alky prod 2500.
Key personnel—A. T. Smith, supt; J. E. Harrell, asst supt; J. L. Laird, asst supt; L. W. Plummer, chf engr.
Constr plans—15,000 Rexformer by Treco, onstream Jun-57; 7000 UOP Unifiner by Treco, onstream Jun-57; 700 Udex by Treco, onstream Sept-57; 30,000 gpm cooling tower by Hudson, compl Jun-57; 1,750,000 bbl tankage by GATX, compl fall-58; two 75,000 lb/hr boilers by Vogt, compl Jun-57.

SUPERIOR ASPHALT CO **212**
1711 S Soto St, Los Angeles 23, Calif.
Parent, Mundo Engineering Co, C. O. Sparks, Inc.

• **Oxnard, Calif**—Idle **212-1**
Rt 2, Box 139, Oxnard, Calif; ph (Los Angeles) Angelus 1-1433.
Crude oper cap (when oper) 2000.
Prin prods—asphalt
Key personnel—H. G. Kayser (at Los Angeles), genl mgr.

SURE SEAL CORP **213**
PO Box 1116, Woods Cross, Utah; ph AX 5-3401. W. M. Barnes, genl mgr. Subsid, Suseco, Co.

SUSECO CO **214**
PO Box 1116, Woods Cross, Utah; ph AX 5-3401. Parent, Sure Seal Corp.

• **Woods Cross, Utah** **214-1**
6355 S 11th W, Woods Cross; mail & ph as above.
Crude oper cap 665 oper, 35 idle.
Prin prods—htg oils 100, fuel oils 150, paraffin waxes 1,000,000 lb/mo, asphalt 5 t/cd.
Key personnel—W. M. Barnes, genl mgr; L. A. Trimble, plt supt.

T

TEXAS ASPHALT & REFINING CO **215**
502 Melrose Bldg, Houston 2, Tex; ph CApitol 8-8583. F. M. O'Connor, VP & rfy mgr.

• **Pasadena, Texas** **215-1**
mi from city, on Houston Ship Channel; 1500 Witter Rd (PO Box 7811), Pasadena; ph GReenwood 3-3375.
Crude oper cap 5000.
Prin prods—jet fuels 2000, htg oils 1000, asphalt 2000.
Fuel proc units—2 stage vac dist 5000.
Key personnel—D. R. Tillery, rfy supt, opers supt, tech dept mgr.

TEXAS CALGARY CO* **216**
229 S State St, Dover, Del. Exec offices, 330 Petroleum Bldg, Abilene, Tex.

• **Lodge Grass, Mont** **216-1**
Crude oper cap 1100.

• **Corrizo Springs, Texas**—building **216-2**
Crude oper cap 2000.

TEXAS CITY REFINING, INC **217**
PO Box 1271, Texas City, Tex; ph 5-4451.

• **Texas City, Tex** **217-1**
foot of 6th St; mail & ph as above.
Crude oper cap 31,000.
Prin prods—mtr gaso 11,250, avgas 3200, jet fuels 3900, htg oils 13,000, fuel oils 3000, rfy gas liqs 580.
Fuel proc units—Houdriflow cat crack 14,400 total, visbreak 4550, UOP HF alky prod 2325.
Key personnel—W. H. Fetter, VP & genl mgr; H. Wood, plt supt; K. E. Agee, chf engr.
Constr plans—7000 Houdriformer by Catalytic Const Co., onstream late-57.

TEXAS COMPANY, THE **218**
135 E 42nd St, New York 17, NY; ph MUrrayhill 9-7700. (Subsid, McColl-Frontenac Oil Co Ltd)*

• **Wilmington, Calif** (Los Angeles Wks) **218-1**
in Wilmington, bounded on W by Goodrich Ave & Alameda St, approx 30 mi S of Los Angeles center; PO Box 817, Wilmington; ph Terminal 4-4521.
Crude oper cap 60,000.
Fuel proc units—fluid cat crack 28,000 total, therm crack 10,000, Platformer 10,000, Hydrotreater 9000, sulf acid alky prod 4400.
Key personnel—W. J. Ryan, supt; C. B. McAllister, asst supt; E. E. Aine, asst supt; F. C. Halpin, chf engr.

• **Claymont, Del** (Delaware River Asph Plt) **218-2**
1½ mi NE of Claymont on Port Rd, 8 mi NE of Wilmington, Del; Drawer 127, Claymont; ph Chester 5-1177.
Crude oper cap 3500.
Key personnel—J. C. Grant, Jr, supt; W. J. Taylor, genl frmn.

• **Lawrenceville, Ill** **218-3**
SE side of city on Market St extension; PO Box 311, Lawrenceville; ph 241.
Crude oper cap 60,000.
Fuel proc units—fluid cat crack 30,000 total, therm crack 12,000, Unifiner-Platformer 13,-50, cat poly prod 2500, sulf acd alky prod 2000.
Key personnel—H. A. Lord, supt; F. D. Dorr, asst supt; V. K. Brandenburg, asst supt; D. Browning, Jr, chf engr.

• **Lockport, Ill** **218-4**
adjoin Lockport, W 2nd St from N State St; Drawer "D", Lockport; ph 770.
Crude oper cap 65,000.
Fuel proc units—fluid cat crack 30,000 total, therm crack 15,000, Unifiner-Platformer 10,-000, cat poly prod 600, sulf acid alky prod 4400.
Key personnel—E. W. McNealy, supt; W. H. Markle, asst supt; F. D. Davis, asst supt; M. C. Lorenzen, chf engr.
Constr plans—10,000 Unifiner-Platformer by The Texas Co & others, fourth quarter-57.

• **Sunburst, Mont** **218-5**
2 mi W of Sunburst, PO Box 166; ph Webster 7-2311.
Crude oper cap 8000.
Fuel proc units—therm crack 5000, cat poly prod 100.
Key personnel—E. J. Scheibe, supt; E. W. Grogan, asst supt; F. J. Engel, plt engr.

• **Westville, NJ** (Eagle Point Wks) **218-6**
adjoins Westville on E, 5 mi S of Camden on Rt 130; PO Box 98, Westville, ph Gloucester 6-1380.
Crude oper cap 66,000.
Fuel proc units—fluid cat crack 35,000 total, Unifiner-Platformer 12,000, therm reform 9000, Hydrotreater 6000, cat poly prod 2500, sulf acid alky prod 1600.
Key personnel—H. H. Chandler, supt; W. E. Toms, asst supt; W. R. Sorenson, asst supt; J. H. Riess, chf engr.
Constr plans—12,000 visbreaker by Treco, compl 1st quarter-57.

• **Tulsa Okla** (West Tulsa Wks) **218-7**
adjoins W Tulsa on SE, 3 mi SW of Tulsa; PO Box 2389, Tulsa 1; ph Luther 4-7246.
Crude oper cap 35,000.
Fuel proc units—fluid cat crack 15,000 total, therm crack 9000, Unifiner-Platformer 8000, therm reform 5000, cat poly prod 1500.
Key personnel—S. W. Darling, supt; G. E. Crews, asst supt; J. J. Rasor, assts supt; J. A. Ruth, chf engr.

• **Providence, RI** (Asphalt Plt) **218-8**
Allens Ave & Providence River; PO Box 2007, Edgewood Sta, Providence; ph Hopkins 1-6600.
Crude oper cap 3500.
Key personnel—C. Z. Walsh, supt; R. F. Clough, asst supt; C. E. Whitehorne, engr.

• **Amarillo, Texas** **218-9**
3 mi NE of Amarillo on extension of Grand Ave; PO Box 2530, Amarillo; ph Drake 4-4691.
Crude oper cap 15,000.
Fuel proc units—fluid cat crack 8000 total, therm crack 2000, Unifiner-Platformer 4500, delayed coking 3500 feed, cat poly prod 200, sulf acid alky prod 800.
Key personnel—S. W. Johnson, supt; D. W. Cunningham, asst supt; K. C. Cramer, plt engr.

• **El Paso, Texas** **218-10**
4 mi NE of El Paso on Womble Blvd; PO Box 5278, Ascarate Branch, El Paso; ph Prospect 2-1433.
Crude oper cap 13,000.
Fuel proc units—fluid cat crack 7000 total, therm crack 2000, Unifiner-Platformer 3500, delayed coking 3500 feed, cat poly prod 500.
Key personnel—H. C. Wakefield, supt; R. R. Chase, asst supt.

• **Port Arthur, Texas** **218-11**
adjoining Port Arthur, foot of Houston Ave; PO Box 712, Port Arthur; ph Yukon 5-4340.
Crude oper cap 230,000.
Fuel proc units—fluid cat crack 60,000 total, therm crack 109,000, Unifiner-Platformer 40,-000, therm reform 17,500, cat poly prod 1800, sulf acid alky prod 12,000.
Key personnel—F. L. Wallace, wks mgr; H. Flynn, genl supt; T. S. Booksh, chf engr.
Constr plans—80,000 (replacing 60,000 of existing) vac pipe still by Fluor, compl 1-1-58; fluid cat crack by Kellogg, compl 4-1-58; 2000 increase in alky unit by the Texas Co & others, compl 4th quarter-57; 900 lb/hr stm, 15,-000 kwh power plant by Jackson & Moreland, The Texas Co. & others, compl 4th quarter-57.

• **Port Neches, Texas** **218-12**
mi SE of Port Neches on Neches River; Drawer 1537, Port Neches; ph 4331.
Crude oper cap 40,000.
Key personnel—C. N. Harless, supt; J. T. Yardley, asst supt; H. E. Ulrich, plt engr.

• **Casper, Wyo** **218-13**
3 mi E of Casper on Yellowstone Hwy; PO Box 320, Casper; ph 2-5377.
Crude oper cap 17,000.
Fuel proc units—fluid cat crack 6000 total, Unifiner- Platformer 4000, cat poly prod 500.
Key personnel—A. E. Higgs, supt; C. T. Swan, asst supt; M. J. Hongartner, chf engr.

• **Anacortes, Wash**—building (Puget Sound Wks) **218-14**
3 mi SE of Anacortes on Fidalgo Island, 67 mi NE of Seattle.
Constr plans—40,000 vac pipe still, 25,000 fluid cat cracking with feed Unifiner, 7000 Unifiner-Platformer, 11,000 Hydrotreater (Texaco) 2000 sulf acid alky (Texaco), 1000 UOP poly—work by Bechtel for completion 1st quarter 1959.

THREE RIVERS REFINERY* **219**
6 E Fifth Ave, Midstates Bldg, Tulsa, Okla; ph Cherry 2-8271. Agnes C. Boudreau, Pres.

• **Three Rivers, Texas** **219-1**
ph 126 & 236.
Crude oper cap 1100 skimming.

THUNDERBIRD CORP* **220**
see Arizona Refineries, Inc & Proven Oil & Refining Co for similar plans.

• **Florence-Coolidge, Ariz**—planned **220-1**
cost estimated at $30-million.
Crude oper cap 16,500.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

Thunderbird Corp (cont)
Constr plans—General contract awarded to Ebasco.

TIDEWATER OIL CO 221
79 New Montgomery St, San Francisco 20, Calif; ph EX 2-4800. (Formerly Tide-Water Associated Oil Co.)* Subsid, Seaside Oil Co.

• **Associated, Calif** (Avon Rfy) 221-1
37 mi NE of San Francisco, Calif; ph Martinez 1220.
Crude oper cap 108,000.
Prin prods—mtr gaso 35,300, avgas 6900, jet fuels 5100, htg oil 18,500, fuel oils 36,600, lube oil 600, rfy gas liqs 2000, greases.
Fuel proc units—fluid crack 40,500 fresh & no recycle, therm crack 16,000 fresh & no recycle, Platformer 9000, 2 Unifiners 31,000, butane isom prod 3000, fluid coker 38,000, therm crack 24,800, sulf acid alky prod 6000.
Key personnel—O. Larsen, rfy mgr; P. H. Woods, chf engr.
Constr plans—22,500 Houdriformer by Bechtel, for 1958 comp; 500,000 lb/hr steam plant by Bechtel, for 1958 compl.

• **Delaware City, Del** 221-2
15 mi S of Wilmington, Del; ph Taylor 4-4581.
Crude oper cap 120,000.
Fuel proc units—fluid cat crack 52,200 fresh & 41,800 recycle, Houdriformer 41,500, Unifiners 81,400, Fluid Coker 38,750, UOP poly prod 4800, Kellogg alky prod 4600, UOP extraction 24,900, Girdler Hydrogen mfr 27,700 mcf/d.
Key personnel—G. C. Caine, div mtg mgr & rfy mgr; J. McDonald & B. G. Jones, asst rfy mgrs; J. J. Mack chf engr.

TYDAL CO, THE* 222
PO Box 553, Gainesville, Tex; ph HOward 5-4142.

• **Gainesville, Texas** 222-1
Crude oper cap 2000.

U

U. S. OIL & REFINING CO 223
3001 Marshall Ave, Tacoma 1, Wash; ph FUlton 1651. E. E. Lyder, Pres, 221 W 23rd St, Los Angeles 7, Calif; ph Richmond 7-6267. Formerly Pacific Oil & Refining Co.

• **Tacoma, Wash**—building 223-1
*Refinery under construction by J. P. Gill, onstream 1957.
***Crude oper cap** 8000.

UCAN PRODUCTS CO* 224
PO Box 2039, Tulsa, Okla. Subsid (80%) of Sunray Mid-Continent Oil Co.

• **Duncan, Okla** 224-1
operates delayed coker at Duncan refinery of D-X Sunray Oil Co.

UINTA OIL REFINING CO* 225
580 W 13th S, Salt Lake City, Utah. Parent, Utah Cooperative Assn.

• **Jensen, Utah** 225-1
Box 107.
Crude oper cap 1200.

UNION OIL CO OF CALIF 226
617 W 7th St, Los Angeles 17, Calif; ph MAdison 9-3261.

• **Arroyo Grande, Calif** (Santa Maria Rfy) 226-1
3½ mi S of Oceano, ½ mi W of Hwy 101, San Luis Obispo Cty; mail, Route 1, Box 7600, Arroyo Grande; ph Guadalupe 3134.
Crude oper cap 21,500.
Prin prods—cracked & syn gaso 3600.
Fuel proc unit—thermal coking.

• **Bakersfield, Calif** (Maltha Rfy) 226-2
2217 China Grade Loop Rd in Bakersfield; PO Box 1759; ph Export 9-0802.
Crude oper cap 8100.
Prin prods—asphalt & road oil 2300.
Fuel proc unit—straightrun dist.

• **Rodeo, Calif** (Oleum Rfy) 226-3
San Pablo Bay, 1 mi N of Rodeo, Contra Costa Cty; ph Rodeo 4411.
Crude oper cap 43,800.
Prin prods—cracked gaso 4500, cat reformate 12,000, coker gaso 2200.
Fuel proc units—crude vac 5800, crude dist 38,000, thermal crack 13,000, coker 12,000, Platformer 12,000.

• **Santa Maria Calif** (Orcutt Rfy) 226-4
3½ mi SW of Santa Maria, off Blasser Rd, Santa Barbara City; Drawer 3, Santa Maria; ph Walnut 5-2443.
Crude oper cap 4700.
Prin prods—cracked & syn gaso 500.
Fuel proc units—crude dist 4700, visbreak (shutdown) 2500.

• **Wilmington, Calif** (Los Angeles Rfy) 226-5
1600 W Anaheim Blvd, in Wilmington; PO Box 758, Wilmington; ph Terminal 4-3421.
Crude oper cap 109,000.
Prin prods—thermal gaso 6700, alky 4500, cat gaso 21,500.
Fuel proc units—hvy crude topping 22,000, light asphalt or crude topping 23,500, combin crude fract & therm crack 63,500, alky 4500, TCC cat crack 16,000 total, fluid cat crack 26,000 total.

• **Cut Bank, Mont** 226-6
5 mi E of Cut Bank on US Hwy 2; PO Box 298, Cut Bank; ph Cut Bank 693.
Crude oper cap 3800.
Prin prods—thermal gaso 1030, poly gaso 70, cat reformate 550.
Fuel proc units—crude dist 3800, therm crack 1900, poly prod 70, Catformer 550.

• **Edmonds, Wash** 226-7
on Puget Sound in Edmonds; PO Box 240, Edmonds; ph Greenwood 2076.
Crude oper cap 4000.
Prin prod—asphalt.
Fuel proc unit—crude dist 4000.

UNITED REFINING CO 227
PO Box 780, Warren, Pa; ph 880. C. W. Cable, Controller of Proc.

• **Warren, Pa** 227-1
E end of Warren, Pa, one block S of US 6; mail & ph as above.
Crude oper cap 7025.
Prin prods—mtr gaso 2175, htg oils 2511, fuel oils 479, lube oil 703, wax 177, asphalt 500.
Fuel proc units—UOP fluid cat crack 2500 with LPG recovery poly unit, caustic wash system for gas and light cycle oil; Catformer 2600, Union Unifiner 750.
Key personnel—H. A. Logan, Jr., VP; D. W. Dorsey, supt; W. D. Harbert, chf engr.

UNITY PETROLEUM CORP 228
Kalispell, Mont; ph SK 6-3511. W. B. Arrow, Pres.

• **Kalispell, Mont** 228-1
½ mi E of town on Hwy 2; Box 371, ph as above.
Crude oper cap 1000.
Prin prods—jet fuels 125, htg oils 250, fuel oils 400, asphalt 200.

UTAH OIL REFINING CO 229
PO Box 898, Salt Lake City 10, Utah; ph Davis 8-8466. Parent, Standard Oil Co (Ind).

• **Salt Lake City, Utah** 229-1
NW Salt Lake City proper, on US 89-91; mail & ph as above.
Crude oper cap 29,400.
Prin prods—mtr gaso 14,100, avgas 1800, jet fuels 1500, htg oils 2550, fuel oils 4700, lube oil 70, rfy gas liqs 400, waxes 20.
Fuel proc units—fluid cat crack 16,500 fresh & no recycle, Holmes-Manley therm crack 5,200 fresh & 1500 recycle, Ultraformer 5000, UOP phos acid poly prod 800, cold sulf acid alky prod 3500, Kellogg propane decarbonizing 10,500.
Key personnel—R. C. Clark, rfy mgr; R. C. Watkins, rfy supt; C. W. Nysewander, asst supt; H. M. Thomson, chf engr.
Constr plans—140,000 lb/hr (300 psig steam Babcock-Wilcox carbon monoxide boiler by Stearns-Roger Co, onstream Feb-58.

V

VALVOLINE OIL CO 230
Freedom, Pa; ph Spence 4-2020. Parent, Ashland Oil & Refining Co (Ky). (Formerly Freedom-Valvoline Oil Co.)*

• **Freedom, Pa** 230-1
on Penna Hwy 88 in Freedom.
Crude oper cap 5075.
Prin prods—mtr gaso 500, jet fuels 400, htg oils 1750, fuel oils 190, lube oil 1050, waxes & petrolatum 225.
Key personnel—J. L. Blount, rfy supt; K. W. Nickols, asst supt; P. M. Robinson, asst supt.

VICKERS PETROLEUM CO, INC, THE 231
PO Box 2240, Wichita 1, Kans; ph Murray 3-6566. A. M. Schrepfer, VP-mfg.

• **Potwin, Kans** 231-1
in Potwin; ph 40.
Crude oper cap 15,000.
Prin prods—mtr gaso 7200, jet fuels 2000, htg oils 3500, fuel oils 1500, rfy gas liqs 350.
Fuel proc units—cat cracker 5800 fresh & 1400 recycle, therm crack 3000 fresh & 7000 recycle, therm reform 1500, poly prod 500.
Key personnel—T. B. Arnold, rfy mgr; R. N. Moore, proc supt; R. S. Gibson, chf engr.
Constr plans—3500 Ultraformer with St Ind pretreater by Parsons, onstream June-57.

VULCAN ASPHALT REFINING CO* 23
Box 186, Cordova, Ala; ph Hudson 3-3621

• **Cordova, Ala** 232-
Crude oper cap 1800.

W

WAGGONER ESTATE, W. T. 233
Vernon, Tex. J. Biggs, genl mgr. Company no longer in refining business.

WARRIOR ASPHALT CORP 234
Box 207, Tuscaloosa, Ala; ph Plaza 8-8131. E. T. Lance, Pres.

• **Tuscaloosa, Ala** (Holt Plt) 234-1
mail & ph as above.
Topping cap (heavy asphaltic crude) 1500
Prin prods—htg oils 180, fuel oils 420, asphalt 900.
Key personnel—E. T. Lance, Pres & Genl Mgr; W. K. Woods, supt.

WARWICK WAX CO, INC 235
1010 - 44th Ave, Long Island City 1, NY. J. J. Fish, dir of research & rfg.

• **Chanute, Kans** 235-1
2 mi S of Chanute; Box 558; ph 275.
Prin prods—waxes (microcrystalline, oxidized microcrystalline, polymers).
Key personnel—G. C. Hatfield, rfy supt; C. Arnold, opers supt.

WEST BRANCH REFINERIES, INC 236
West Branch, Mich; ph 212. Parent, Osceola Refining Co. (Formerly Producers Refining, Inc.)*

• **West Branch, Mich** 236-1
Mail & ph as above.
Crude oper cap 5000 b/cd.
Prin prods—mtr gaso 8000 bbl/mo, htg oils 15,000 bbl/mo, fuel oils 15,000 bbl/mo.
Key personnel—R. J. Potts, supt.

WESCO REFINING CO* 237
Box 216, Rangely, Colo. E. W. Forbes, Pres & genl mgr.

• **Rangeley, Colo** 237-1
Crude oper cap 1700 skimming.

WESTOIL TERMINALS CO* 238
221 W 23rd St, Los Angeles, Calif. G. W. Gage, Pres. Affil of Time Oil Co.

• **Wilmington, Calif**—shutdown 238-1
1601 Wilmington, San Pedro Rd, San Pedro (Box 990), Calif. Also operates a terminal.
Crude oper cap (when oper) 25,000.

WESTERN ASPHALT & REFINING CO 239
PO Box 225, Santa Maria, Calif.

• **Santa Maria, Calif**—idle 239-1
leased to Douglas Oil Co. of Calif.
Crude oper cap (when oper.) 1500.

WESTERN RESERVE REFINING CO 240
Niles, Ohio; ph Olympic 2-2532. Parent, Ashland Oil & Refining Co (Ky).

• **Niles, Ohio**—shutdown 240-1
Ohio Rt 169, midway between Warren & Niles; mail & ph as above.
Crude oper cap for 1956 was 1325 oper, 4500 idle. Now operating as a terminal.

WESTERN STATES REFINING CO 241
PO Box 200, North Salt Lake City, Utah; ph DA 2-5893. E. E. Evans, secy-treas. Subsid, Four States-Western Oil Refining Co.

• **North Salt Lake City, Utah** 241-1
7 mi N of Salt Lake City; mail and ph as above.
Crude oper cap 3500 oper, 250 idle.
Prin prods—mtr gaso 1600, htg oils 40, fuel oils 470, rfy gas liqs 280.
Fuel proc units—therm crack 1500, cat reform 750.
Key personnel—O. Winegar, rfy supt; L. Carroll, opers supt; R. Martin, chf engr.

• **Farmington, NM*** 241-2
Crude oper cap 1200.

WESTLAND OIL CO 242
504 E Central Ave, Minot, ND; ph 4-1176. R. J. Coughlin, Jr, VP-rfg. (Formerly Williston Basin Refining Co.)*

• **Williston, ND** 242-1
2 mi E of Williston on Scenic Hwy; PO Box 843, Williston; ph 3-3600.

Crude oper cap 2000.
Prin prods—mtr gaso 1100, #1 & 2 htg oils 25 & 6 fuel oils 600.
Fuel proc units—Dubbs therm crack 1000, Platformer 200.
Key personnel—T. A. Moore, supt.
Constr plans—1000 UOP therm crack by Petroleum Piping Contractors, compl 5-57; 530 Platformer by staff, compl 5-57; revamp of crude unit from 1500 to 2000 almost complete.

WICKETT REFINING CO 243
Box 307, Wickett, Tex; ph 1595 Mohahans, Tex. E. L. Kent, res & rfy mgr.

• **Wickett, Texas** 243-1
7 mi W of Mohahans on Hwy 80 & T&P Ry, 1 mi W of Wickett; mail & ph as above.
Crude oper cap 3500.
Prin prods—mtr gaso 2000, htg oils 700, fuel oils 900.
Key personnel—J. R. Edgerton, supt.

WILCOX OIL CO 244
Box 1440, Tulsa, Okla.

• **Bristow, Okla**—shutdown 244-1
closed Aug, 1956.
*Crude oper cap 5500.

WILSHIRE OIL CO OF CALIF 245
727 W 7th St, Los Angeles 17, Calif. Parent, Malco Refineries, Inc (purchased 1955.)*

• **Norwalk, Calif** 245-1
13539 E Foster Rd (PO Box 187) Norwalk; ph Ludlow 8-6396.
Crude oper cap 30,000.
Prin prods—mtr gaso 9800, jet fuel 6000, htg oils 1600, fuel oils 12,200, rfy gas liqs 1000, asphalt 1400.
Fuel proc units—UOP fluid cat crack 7500, Dubbs therm crack 8000 fresh & 4000 recycle, Unifiner-Platformer 10,000, UOP poly prod 600, UOP isom 800, UOP alky prod 1800.
Key personnel—J. H. Ouding, mgr mfg; L. Earl, asst mgr-mfg; S. J. Lindsay, chf engr.

WIREBACK OIL CO* 246
Plymouth, Ill; ph 135. Mrs. B. F. Wireback, owner & mgr.

• **Plymouth, Ill.** 246-1
mail & ph as above.
Crude oper cap 1200 skimming.
Key personnel—A. F. Crane, supt; R. K. Bell, genl mgr.

WOLF'S HEAD OIL REFINING CO, INC* 247
Wolf's Head Bldg, Oil City, Pa; ph 5-1231. A. W. Scott, Pres.

• **Reno, Pa** 247-1
Reno, Pa.
Crude oper cap 2500.

WOOD RIVER OIL & REFINING CO* 248
321 W Douglas Ave, Wichita, Kans; ph AM 5-5674. F. C. Koch, Pres. Subsid, Prime Oil Co.

• **Hartford, Ill** 248-1
Crude oper cap 30,000.

Canadian Refineries

ANGLO AMERICAN EXPLORATION, LTD* 249
330 – 9th Ave W, Anglo American Bldg, Calgary, Alberta, Canada; ph 691341. S. C. Nickle, Pres. Parent, Anglo American Oils Ltd.

• **Hartell, Alberta** 249-1
Box 38; ph Turner Valley 22-R2.
Crude oper cap 4000.

ANGLO-CANADIAN OILS LIMITED 250
Box 99, Brandon, Manitoba, Canada, ph 2361.

• **Brandon, Manitoba** 250-1
corner of Richmond Ave & Hwy 10 S; mail & ph as above.
Crude oper cap 2800.
Prin prods—mtr gaso 1400, htg oils 560, fuel oils 620, rfy gas liqs 35.
Fuel proc units—Dubbs 2-coil thermal crack 3720 fresh and 1240 recycle, Platformer 1000, UOP cat poly prod 35.
Key personnel—A. C. Morrison, rfy supt; H. W. Collister, asst to supt.

BONNEYVILLE OIL & REFINING CORP* 251
Room 420, 1410 Stanley St, Montreal, Quebec, Canada; ph Avenue 8-2886. T. E. Dubuc, Pres.

• **Bonneyville, Alberta** 251-1
Crude oper cap 1000.

BRITISH AMERICAN OIL CO LTD, THE 252
800 Bay St, Toronto, Ontario, Canada; ph WAlnut 4-4141. J. W. Morgan, genl mgr-mfg dept.

• **Calgary, Alberta** 252-1
Box 279, Calgary.
Crude oper cap 6750.
Fuel proc units—therm crack 2250 fresh & 4950 recycle, Catformer 1800.
Key personnel—M. T. Stevens, rfy mgr; H. A. Hornfelt, asst rfy mgr; J. P. Choquet, rfy engr.

• **Edmonton, Alberta** 252-2
Box 97, Edmonton.
Crude oper cap 7650.
Fuel proc units—Orthoflow cat crack 1800 fresh & 1800 recycle, therm crack 1260 fresh & 3780 recycle, delayed coking 1890 fresh & 270 recycle.
Key personnel—C. W. Coote, rfy mgr; R. M. Donald, asst mgr; L. Courtice, rfy engr.
Constr plans—5700 cat desulf by Lummus Co, onstream late-57; 3600 Catformer by Lummus Co, onstream late-57.

• **Clarkson, Ontario** 252-3
Crude oper cap 19,300.
Fuel proc units—Orthoflow cat crack 10,400 fresh & 5300 recycle, Polyform therm crack 4050 fresh & 2600 recycle, cat poly prod 1130.
Key personnel—W. E. Lundie, rfy mgr; D. G. Berry, asst mgr; F. V. Drowley, refy engr.
Constr plans—10,800 cat desulf by Lummus, onstream mid-57; 9000 Catformer by Lummus, onstream mid-57; 36,000 crude & vac unit by Kellogg, onstream late-57.

• **Montreal East, Quebec** 252-4
Box 70, Hochelaga PO, Montreal East.
Crude oper cap 45,000.
Fuel proc units—fluid cat crack 19,800 fresh & 2700 recycle, Catformer 11,700, cat poly prod 570.
Key personnel—J. A. McHardy, rfy mgr; R. C. Beal, asst mgr; W. B. Morrison, rfy engr.
Constr plans—14,000 cat desulf by Lummus, onstream mid-57.

• **Moose Jaw, Saskatchewan** 252-5
Crude oper cap 13,500.
Fuel proc units—fluid cat crack 4050 fresh & 4950 recycle, therm crack 1350, delayed coking 2030 fresh & 920 recycle, cat poly prod 350.
Key personnel—B. A. Barnhill, rfy mgr; R. E. Harris, asst mgr; K. C. Reeves, rfy engr.

BRITISH PETROLEUM (CANADA) LTD 253
parent, British Petroleum Ltd, London, England.

• **Montreal, Quebec**—planned 253-1
Crude oper cap 30,000.
Constr plans—$30-million project, constr to start early-57.

CANADIAN OIL COMPANIES LTD 254
204 Richmond St W, Toronto 1, Ontario, Canada; ph Empire 6-3031. (Subsid, Canadian Oil Refineries Ltd.)*

• **Corunna, Ontario** 254-1
mi S of Sarnia on Hwy 40; ph Sarnia Exch. Digby 4-1105.
Crude oper cap 27,500.
Prin prods—mtr gaso 13,500, avgas 100, htg oils 8500, fuel oils 2500, rfy gas liqs 2300.
Fuel proc units—Orthoflow cat crack 10,500 fresh & 7500 recycle, Platformer 4300, visbreak 3600, UOP cat poly prod 330.
Key personnel—V. M. Norwood, rfy mgr; T. J. Barry, proc supt; T. J. Harvey, chf engr.
Constr plans—4400 Platformer by Fluor, onstream June-57; 3650 Udex by Fluor, onstream June-57.

CANADIAN PETROFINA LTD 255
505 Dorchester St W, Montreal, Quebec, Canada. J. R. Patton, VP-rfg.

• **Pointe-aux-Trembles, Quebec** 255-1
11,701 Sherbrooke St E, Pointe-aux-Trembles (10 mi E of Montreal on Quebec Hwy 2). PO Box 70, Hochelaga Sta, Montreal 4; ph MIssion 5-7221.
Crude oper cap 20,000.
Prin prods—mtr gaso 10,500, htg oils 4,000, fuel oils 2000, rfy gas liqs 200, coke 50 t/cd.
Fuel proc units—Houdriflow cat crack 11,000 fresh & 5500 recycle, Ultraformer 3600, Std Ind hydrodesulf 3600, Shell trickle hydrotreat 2500, Fluid Coker 2500, poly prod 450, alky prod 1400.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

Key personnel—C. Bulatko, asst rfy mgr; J. F. Mills, proc supt; R. D. Ayer, chf engr.

CONSUMERS COOPERATIVE REFINERIES LTD 256
211 Ave D, N, Saskatoon, Saskatchewan, Canada. Parent, Federated Cooperatives Ltd.

• **Regina, Saskatchewan*** 256-1
Box 399; ph JO 9-5411
Crude oper cap 15,500.
Prin prods—mtr gaso, htg oils, fuel oils, rfy gas liqs, asphalt.
Fuel proc units—fluid cat crack 5000 fresh & 5000 recycle, visbreak 3000, cat poly prod 500.
Key personnel—B. W. Pawson, supt; B. Dahlstrom, rfy engr; S. C. McClellan, proc supt.

DELKAY OIL LTD* 257
12617 Port Rd, Edmonton, Alberta, Canada.

• **Edmonton, Alberta**—planned 257-1

EXCELSIOR REFINERIES LTD 258
222 Tegler Bldg, Edmonton, Alberta, Canada; ph 4-7376. (Subsid, X-L Refineries Ltd.)*

• **Lloydminster, Alberta** 258-1
ph 3311.
Crude oper cap 3,800 oper, 1,600 idle.
Prin prods—mtr gaso 50, htg oils 500, fuel oils 400, asphalt 1100.
Key personnel—W. D. Green, rfy mgr; W. Graetzer, chf engr.

HUSKY OIL & REFINING LTD 259
815-6th St W, Calgary, Alberta, Canada; ph 6-7291. L. J. Campbell, mgr rfg & mfg; H. C. Spaetgens, chf rfy engr. Parent, Canadian Husky Oil Ltd.

• **Lloydminster, Alberta** 259-1
ph 2201.
Crude oper cap 5700 oper, 2000 idle.
Prin prods—mtr gaso 400, light fuel oils 800, heavy fuel oils 2600, asphalt 1900.
Fuel proc units—Cycloversion 400.
Key personnel—L. W. Cavanagh, rfy supt.
Constr plans—35,000 lb/hr boiler, planned for late-57 compl.

• **Fort William, Ontario** 259-2
Island No 1, Fort William; ph 2-6431.
Crude oper cap 3450.
Prin prods—mtr gaso 700, light fuel oils 700, heavy fuel oils 1600, asphalt 380.
Fuel proc units—Catformer 1000.
Key personnel—R. D. Stevens, rfy supt.
Constr plans—1000 Diesulformer planned for late-57 or early-58 compl; 30,000 lb/hr boiler, planned for late-57 compl; 250 b/sd Husky asphalt blow still, onstream May-57.

• **Moose Jaw, Saskatchewan** 259-3
Box 280, Moose Jaw; ph 2-1834 (long dist call 2-1836).
Crude oper cap 4000.
Prin prods—mtr gaso 410, light fuel oils 800, heavy fuel oils 2100, asphalt 620.
Fuel proc units—Catformer 650, Diesulformer 1000, Fluor visbreak 1300.
Key personnel—R. L. Miller, rfy supt.

IMPERIAL OIL LTD 260
111 St Clair Ave W, Toronto 7, Ont, Canada; ph WA 4-9111. D. S. Simmons, genl mgr-mfg dept. Parent, Standard Oil Company (NJ).

• **Calgary, Alberta** 260-1
4½ mi SE of downtown Calgary (Box R181, on banks of Bow River; ph 5-1001.
Crude oper cap 9200.
Prod—asphalt 920.
Fuel proc units—therm crack 5400 total fresh, sulph acid alky prod 850.
Key personnel—J. J. Hanna, rfy mgr; D. T. Fotheringham, plt supt; F. L. Perry, proc supt; J. J. Scott, tech supt.

• **Edmonton, Alberta** 260-2
S bank of N Saskatchewan River, about 3½ mi E of Edmonton (Box 3081; ph 6-4522.
Crude oper cap 25,000.
Prod—lubes 2000.
Fuel proc units—fluid cat crack 8000 fresh & 4800 recycle, therm crack 10,100 total, Powerformer 2200, lube hydrofiner 2700.
Key personnel—E. K. Lewis, rfy mgr; S. T. Reynolds, plt supt; F. B. Doull, proc supt; M. E. O'Loughlin, tech supt.

• **Ioco, British Columbia** 260-3
11 mi E of Vancouver on N shore of Burrard Inlet; ph Pacific 8231 (Ioco 541.
Crude oper cap 25,000.
Prod—asphalt 630.
Fuel proc units—fluid cat crack 7650 fresh & 4150 recycle, cat poly prod 2490.
Key personnel—A. G. Stewart, rfy mgr; H. L. Cavanagh, plt supt; J. E. Potkins, proc supt & tech supt.

Imperial Oil Ltd (cont)
Constr plans—5800 Powerformer, onstream Dec-57.

• **Winnipeg, Manitoba** **260-4**
E St Paul, 10 mi N of Winnipeg (Box 836), on Henderson Hwy; ph Edison 1-4331.
Crude oper cap 15,000.
Prod—asphalt 220.
Fuel proc units—fluid cat crack 4600 fresh & 1800 recycle.
Key personnel—H. F. Wheaton, rfy mgr; G. H. Dyer, plt supt; M. Moorhouse, proc supt; T. C. Elliott, tech supt.
Constr plans—3150 Powerformer, onstream Oct-57; 2500 crude facilities expansion; 1100 cat crack expansion.

• **Norman Wells, Northwest Territory** **260-5**
Northern-most Canadian refinery, on 65th parallel of latitude, 90 mi S of the Arctic Circle.
Crude oper cap 1300.
Key personnel—J. S. L. McMillan, rfy mgr.

• **Dartmouth, Nova Scotia** (Halifax Rfy) **260-6**
2½ mi S of Dartmouth (Box 219), across harbor from Halifax; ph 6-2161.
Crude oper cap 42,000.
Prod—asphalt 940.
Fuel proc units—fluid cat crack 13,500 fresh & 12,300 recycle, visbreak 10,900, Powerformer 6300, cat poly prod 4900.
Key personnel—H. H. Moor, rfy mgr; M. MacLeod, plt supt; C. J. Fitzgerald, proc supt; R. L. Norman, tech supt.

• **Sarnia, Ontario** **260-7**
E bank of St Clair river, just S of Sarnia; ph Edgewater 7-8221.
Crude oper cap 80,000.
Prods—lube oils 3200, coke 24 t/d, asphalt 2200, wax 650.
Fuel proc units—fluid cat crack 19,300 fresh & 7500 recycle, therm crack & visbreak 8,800 total, Powerformer 15,000, therm reform 8900, lube Hydrofiner 3,400, wax mfg 35 MM lb/yr.
Key personnel—G. R. McMillin, rfy mgr; W. J. Beynon, asst rfy mgr; G. G. Paterson, proc supt; R. J. Donald, tech supt; J. E. MacDonald, plt supt.
Constr plans—150 MM lb/yr ethylene steam cracker by Bechtel, onstream summer-58.

• **Montreal East, Quebec** **260-8**
N bank of St. Lawrence River, about 10 mi E of Montreal; Box 1510 Place D'Armes, Montreal East; ph Mission 5-5881.
Crude oper cap 69,000.
Prod—asphalt 3600.
Fuel proc units—fluid cat crack 18,400 fresh & 9600 recycle, Powerformer 8500, therm ref 4700, visbreak 12,000, cat poly prod 5400.
Key personnel—J. L. Huggett, rfy mgr; J. J. Rowan, asst rfy mgr; S. J. Voce, proc supt; L. J. Orr, tech supt.

• **Regina, Saskatchewan** **260-9**
Near N limits of Regina (Box 400); ph Jordan 9-5401.
Crude oper cap 22,500.
Prod—asphalt 214.
Fuel proc units—fluid cat crack 8500 fresh & 6500 recycle; therm crack 5000, therm reform 3400, cat poly prod 320.
Key personnel—W. O. Longworthy, rfy mgr; H. R. Holland, plt supt; F. Sharp, proc supt; W. T. Bothwell, tech supt.

LION REFINING CO LTD* **261**
1333-9th Ave West, Calgary, Alberta, Canada.

• **Calgary, Alberta**—shutdown **261-1**

McCOLL-FRONTENAC OIL CO LTD **262**
1425 Mountain St, Montreal, Que, Canada; ph PL 4281. A. G. Garquharson, VP-rfg. Parent, The Texas Co; subsid, Regent Refining (Canada) Ltd.

• **Edmonton, Alberta, Canada** **262-1**
PO Box 669, Edmonton.
Crude oper cap 11,500.
Prin prods—mtr gaso 5500, jet fuels 500, htg oils 2600, fuel oils 825, rfy gas liqs 600, coke 270 t/cd.
Fuel proc units—fluid cat crack 3400 fresh & 1100 recycle, therm crack 2400, Unifiner-Platformer 3300, delayed coking 1487, cat poly prod 279, press flash.
Key personnel—H. M. Williams, supt; G. W. Hayward, asst supt; D. H. Sands, chf engr.

• **Montreal East, Quebec, Canada** **262-2**
10200 Notre Dame St E, Montreal East.
Crude oper cap 55,000.
Prin prods—mtr gaso 19,000, jet fuels 1600, htg oils 18,500, fuel oils 12,500, rfy gas liqs 2000.
Fuel proc units—fluid cat crack 20,000 fresh & 4000 recycle, Unifiner-Platformer 11,000, visbreak 12,500, cat poly prod 1350, press flash 20,246.
Key personnel—H. M. Bolitho, supt; G. F. Webster, asst supt; E. G. Rosengren, asst supt; W. Veinot, chf engr.
Constr plans—10,000 Hydro-Treater by Foster Wheeler, onstream late-57.

NEW BRUNSWICK OILFIELDS LTD **263**
PO Box 194, Moncton, New Brunswick, Canada. C. T. R. Wilson, genl mgr.

• **Weldon, New Brunswick** **263-1**
Albert Cty; mail as above.
Crude oper cap 100 oper, 200 idle.
Prin prods—mtr gaso 7, fuel oils 88.

NORTH STAR OIL LTD **264**
Box 139, St Boniface, Manitoba, Canada; ph 231-401. W. R. Macarthur, VP.

• **Grande Prairie, Alberta** **264-1**
SE ¼ Sec 22 & portion of NE ¼ Sec 22, TP 71, Rge 6—West 6th M, lying S of ED & BC (NAR) Ry; Box 699, Grande Prairie; ph 2374.
Crude oper cap 2500.
Prin prods—mtr gaso 1100, htg oils 580, fuel oils 560.
Fuel proc units—therm crack 1000, S.B.K. cat reform 875, Kellogg hydrotreat 875.
Key personnel—W. Campbell, rfy supt.

• **St Boniface, Manitoba** **264-2**
Hwy 59 between Mission St & Dugald Rd; mail & ph as above.
Crude oper cap 12,000.
Prin prods—mtr gaso 6350, jet fuels (as required), htg oils 3500, fuel oils 1650, rfy gas liqs 650.
Fuel proc units—Model B Orthoflow 5177 fresh & 4660 recycle, UOP poly prod 390.
Key personnel—W. J. Dubesky, rfy supt; T. B. J. Kruse, rfy engr.

NORTHERN PETROLEUM CORP LTD* **265**
Kamsack, Saskatchewan, Canada; ph 9. J. Kalmacoff, Sr. Pres & genl mgr.

• **Kamsack, Saskatchewan** **265-1**
Crude oper cap 800 skimming.

PARK REFINERY* **266**
Albert Park, Calgary, Alberta, Canada.

• **Calgary, Alberta** **266-1**

PETROLEUM FUELS LTD **267**
PO Box 1500, Moose Jaw, Saskatchewan, Canada; ph Oxford 2-8814.

• **Moose Jaw, Saskatchewan** **267-1**
Selwyn St; mail & ph as above.
Crude oper cap 1100.
Prin prods—jet fuels 200, fuel oils 900.
Key personnel—C. K. Buchbach, rfy mgr.

PRINCE ALBERT REFINERIES LTD **268**
PO Box 309, Prince Albert, Saskatchewan, Canada; ph 6464. Parent, Royalite Oil Co Ltd.

• **Prince Albert, Saskatchewan** **268-1**
700 River St W, Prince Albert; mail & ph as above.
Crude oper cap 900.
Prin prods—mtr gaso 27, htg oils 90, fuel oils 774.
Key personnel—J. C. Browning, rfy supt; W. Smithwick, rfy engr.

RADIO OIL REFINERIES LTD* **269**
Munroe & Watt Sts, East Kildonan, Manitoba, Canada. G. M. Hechter, Pres & genl mgr-rfys.

• **East Kildonan, Manitoba** **269-1**
Crude oper cap 2000.
Key personnel—J. Harris, rfy supt.

REGENT REFINING (CANADA) LTD* **270**
184 Bay St, Toronto 1, Ontario, Canada; ph Empire 6-2581. R. Rosefield, Pres. Was Trinidad Leaseholds (Canada) Ltd. Parent, McColl-Frontenac Oil Co Ltd.

• **Port Credit, Ontario** **270-1**
Crude oper cap 12,600.

ROYALITE HI-WAY LTD **271**
PO Box 1270, Saskatoon, Saskatchewan, Canada; ph 2-1244. Parent, Royalite Oil Co Ltd.

• **Saskatoon, Saskatchewan** **271-1**
Ave West & 11th St W; mail & ph as above.
Crude oper cap 5850.
Prin prods—mtr gaso 2925, jet fuels 100, htg oils 1170, fuel oils 1360, rfy gas liqs 60.

Volumes and capacities given in b/cd unless otherwise noted.
* **Indicates** information not verified by the company.

Fuel proc units—UOP fluid cat crack 234 fresh & 3510 recycle, UOP visbreak 380 Cycloversion desulf 1000.
Key personnel—J. C. Browning, rfy sup F. Robin, chf engr.

ROYALITE OIL CO LTD **27**
Royalite Bldg, Calgary, Alberta, Canada; p AMherst 6-7021. E. F. T. Stevens, mgr mf div. Subsids, Royalite Hi-Way Ltd; Princ Albert Refineries, Ltd. (Formerly Refiner Operators Ltd.)*

• **Coleville, Saskatchewan** **272-1**
Adjacent to Coleville; ph 21.
Crude oper cap 4500.
Prin prods—mtr gaso 135, htg oils 450, fue oils 3870.
Key personnel—J. C. Browning, rfy supt; S Kotyk, rfy engr.
Constr plans—250 asphalt oxidizing by company, onstream Mar-57.

• **Kamloops, British Columbia** **272-2**
PO Box 240, Kamloops; ph 1800.
Crude oper cap 4500.
Prin prods—mtr gaso 1935, htg oils 1300 fuel oils 900, rfy gas liqs 45.
Fuel proc units—UOP cat crack 1260 fresh & 1890 recycle; UOP poly prod 500.
Key personnel—J. Wach, rfy supt; A. G. A. Piercey, proc supt.
Constr plans—1000 Platformer, onstream Dec-57.

SHELL OIL CO (CANADA LTD)* **273**
25 Adelaide St E, Toronto 1, Ontario, Canada; ph Empire 3-8696. W. M. V. Ash, Pres. Parents, Shell Oil Co (50%) & Canadian Shell Ltd (50%).

• **North Burnaby, British Columbia** (Shellburn Rfy) **273-1**
Crude oper cap 19,000.

• **Montreal East, Quebec** **273-2**
Crude oper cap 58,000.

STANDARD OIL CO OF BRITISH COLUMBIA LTD **274**
833 Marine Bldg, Vancouver 1, British Columbia, Canada; ph PAcific 4271. R. T. Wilson, VP, secy-treas. Parent, Standard Oil Company (Calif).

• **Vancouver, BC** (Stanovan Rfy) **274-1**
2 mi E of Vancouver; mail & ph as above.
Crude oper cap 17,000.
Prin prods—mtr gaso 7000, stove oil 2100, diesel oil 3500, fuel oils 2500, rfy gas liqs 600, asphalt 400.
Fuel proc units—Model IV cat crack 3550 fresh & 3550 recycle, Platformer 2600, Calif poly prod 320.
Key personnel—V. Wiebe, rfy mgr; T. S. Bremner, supt; R. C. Freyman, rfy engr.

SUN OIL LTD **275**
PO Box U, Sarnia, Ontario, Canada; ph Edgewater 7-2301. Parent, Sun Oil Co.

• **Sarnia, Ontario** **275-1**
Hwy 40 & Sun Ave; mail & ph as above.
Crude oper cap 15,000.
Prin prods—mtr gaso, htg oils, fuel oils, rfy gas liqs.
Fuel proc units—cat crack 11,000, therm crack, cat reform 3000.
Key personnel—G. R. Henderson, mgr of rfy, F. A. Bain, supt of rfy.

TRUMP OIL CO* **276**
Morris, Manitoba, Canada.

• **Morris, Manitoba**—shutdown **276-1**
Crude oper cap (when oper) 300.

WAINWRIGHT PRODUCERS & REFINERS LTD **277**
PO Box 728, Wainwright, Alberta; ph 438. M. A. Schutz, VP & genl mgr, 127 Montgomery St, San Francisco 4, Calif; ph Yukon 6-5588. Parent, American Northland Oil Co.

• **Wainwright, Alberta** **277-1**
135 mi E of Edmonton, on Hwy 14; mail & ph as above.
Crude oper cap 3500.
Prin prods—mtr gaso 455, jet fuels (alternate) 120, htg oils 90, fuel oils 2955, asphalt (alternate) 900.
Key personnel—R. B. Fowler, rfy mgr; G. Millar, rfy supt & asst mgr.
Constr plans—in planning stage for possible 57 compl: 1600 UOP therm cracker, 600 Platformer, 50 UOP poly prods.

X-L REFINERIES LTD* **278**
Dawson Creek, British Columbia, Canada. Parent, Excelsior Refineries Ltd.

• **Peace River, British Columbia** **278-1**
$2-million refinery onstream late-55.
Crude oper cap 3000.

Refining Process Glossary

By GEORGE H. UNZELMAN
Ethyl Corp., Tulsa, Okla.

and CHARLES J. WOLF
Ethyl Corp., Detroit, Mich.

On the next 53 pages, PETROLEUM PROCESSING presents its first "Refining Process Glossary"—an organized collection of 168 brief descriptions of all the important processes now in commercial use by the industry, or available for such use.

We think we've made this glossary different and better than any other such grouping of process descriptions. And we think you'll find it more useful and helpful for these reasons:

1—The descriptions are organized so you can find the ones you want easily. They are grouped under five general types of processes, and then under 25 specific types—as listed in the contents below. A detailed index appears on pp. 149-150.

2—The descriptions have been written to give you brief, thumbnail, "quick reference" explanations of all the refining processes you are likely to meet in today's operations. If you need to dig into a specific process in detail, you'll find selected references with each description.

3—All of the descriptions were written by a team of two experienced refinery technologists, working on assignment for PETROLEUM PROCESSING.

4—As an added feature, PETROLEUM PROCESSING's editors compiled a listing of firms available to handle process design, mechanical engineering, and/or construction work for specific processes. These firms are listed by code numbers at the end of a process description—the code numbers referring to the Directory of "Who's Who in the Refinery Service Firms" on pp. 150-152.

Meet the Authors

The two engineers who wrote these process descriptions on special assignment for PETROLEUM PROCESSING know their subject well. George H. Unzelman, left, has been in refining technology for nine years, and Charles J. Wolf, right, for ten. Both of them are now on the technical staff of the Ethyl Corp.

George H. Unzelman was graduated from the U. of Washington at Seattle in 1948 with a B.S. degree in Chemical Engineering, and then joined Continental Oil Co.'s Manufacturing Dept. He worked at both the Ponca City, Okla., and Billings, Mont., refineries—as Chief Chemist at the latter. In 1955 he joined the Ethyl Corp.'s Research and Development Dept. in Detroit as a member of the Refinery Technology Group — and worked on engineering and economic studies of various phases of refinery operations. His present position is Refinery Technologist in Ethyl's Southern Regional Offices in Tulsa.

Charles J. Wolf received his B.S. in Chemical Engineering from the U. of Notre Dame in 1947—and immediately went with the Research Laboratories of Standard Oil Co. (Indiana) in Whiting, Ind. The following year he moved to the Technical Service Division (Light Oils Operation). Not content with a B.S., while with Indiana Standard he attended night graduate school and in 1951 received an M.S. in Chemical Engineering from Illinois Institute of Technology. Early in 1953 he moved to the Technical Dept. of Socony Mobil Oil Co.'s refinery at East Chicago, Ind. Later that same year he went with the Refinery Technology Division of Ethyl's Research and Development Dept. in Detroit—his present location.

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CATALYTIC PROCESSES

CATALYTIC CRACKING

Catalytic cracking is a refinery process to convert high boiling non-gasoline hydrocarbons into lower boiling gasoline components. The catalyst may be in a fixed bed, moving bed, or fluid bed. Activated natural or synthetic catalysts—primarily silica alumina or silica magnesia—are employed in bead, pellet or microsphere form. For similar catalyst composition and cracking conditions, natural catalyst results in a higher gasoline yield with lower antiknock quality than the synthetic catalyst.

Feed stocks may range from naphtha cuts (included in normal heavier feed, for upgrading) to reduced crudes. Usually feed preparation—to remove salts and heavy asphalts—is carried out through any one of the following ways: coking, propane deasphalting, furfural extraction, vacuum distillation, viscosity breaking, thermal cracking or hydrodesulfurization.

In catalytic cracking, the major process variables are temperature, pressure, catalyst-oil ratio (ratio of weight of catalyst entering reactor per hour to the weight of oil charged per hour), and space velocity (weight—or volume—of the oil charged per hour per weight—or volume—of catalyst in the reaction zone). Wide flexibility in product distribution and quality are possible through control of these variables along with the extent of internal recycle. Increased conversion can be obtained by: (1) a higher temperature, (2) a higher pressure, (3) a lower space velocity, and, (4) a higher catalyst-oil ratio.

Catalytic cracking as a commercial process came into use in the United States in 1936. In principle—conversion of fuel oil to gasoline—it is in direct competition with thermal cracking, and cracking construction today is essentially for catalytic usage. The first catalytic cracker was of the fixed-bed variety. However, today most cracking processing is carried out in moving or fluid beds. Though the phenomenal growth period of catalytic cracking installation has passed, it is still one of the most important refinery processes, and the ratio of catalytic cracking to crude running capacity will continue to increase gradually in the near future.

General catalytic cracking references include:

(1) Carney, W., and A. W. Hoge, "Lion Oil Co. Catalytically Processes Sour Gas Oil," reviewed in PETROLEUM PROCESSING, Dec. 1948, pp. 1207-9
(2) Conn, A. L., and C. W. Brackin, "Cracking of High Sulfur Stocks, Use of Steam With Natural Catalyst," *Ind. & Engrg. Chem.*, Aug. 1949, pp. 1717+
(3) Goldtrap, W. A., and B. Skinner, "Refinery Conversion for Premium Motor Fuels," *Pet. Engr.*, Apr. 1954, pp. 174+
(4) Nelson, W. L., "Heat of Decomposition in Catalytic Cracking," *Oil & Gas J.*, Nov. 10, 1949, p. 376
(5) Noll, H. D., A. W. Hoge, and D. M. Luntz, "Commercial TCC Operations on Partially Vaporized Charge Stocks," Nat. Pet. Assn., Sept. 1946—reviewed in PETROLEUM PROCESSING, Nov. 1946, pp. 211-8
(6) Oden, E. C., and J. J. Perry, "17 Feeds for Cat Crackers," *Pet. Ref.*, Mar. 1954, pp. 191-3
(7) PETROLEUM PROCESSING, "8000 B/D Refinery Converts Thermal Unit to Catalytic Cracking for $200-250/Bbl," June 1947, pp. 411-16
(8) *Pet. Ref.*, "More Catalytic Cracking Feed," Nov. 1956, p. 160
(9) Porter, R. W., "Unusual Techniques Feature the Production of Synthetic Bead Catalyst," *Chem. & Met. Engrg.*, Apr. 1946, pp. 94+
(10) Sittig, M., "Catalytic Cracking," PETROLEUM PROCESSING, Mar. 1949, pp. 274-80
(11) Sittig, M., "Catalytic Cracking," *Pet. Ref.*, June 1950, pp. 91-5
(12) Sittig, M., "Catalytic Cracking Techniques in Review," *Pet. Ref.*, Sept. 1952, pp. 263-316
(13) Sittig M., "Catalytic Process Mechanics," PETROLEUM PROCESSING, July 1954, pp. 1048-55

Fluid-Bed Catalytic Cracking

Fluidized-bed catalytic cracking processes use microspheri al or powdered catalysts of either natural or synthetic origin. The customary wide range of conventional catalytic charge stocks can be employed to yield gasoline, middle distillates, light olefins and isoparaffins, coke and fuel-oil, and gas. Product qualities and distributions are functions of the charge composition and boiling range as well as the operating conditions of the unit—amount of recycle, catalyst type, catalyst activity, conversion level, etc.

Normal fluid catalytic cracking operating conditions in the reactor are in the ranges of 880-980°F, 10-16 psig 1.0-3.0/1.0 (w/hr/w) space velocity, and 8.0-12.0/1.0 catalyst oil ratio. Regeneration temperatures and pressures are 1050-1100°F and 8-10 psig.

Cracking a gas oil feed at about 60% conversion (based on 100% total possible disappearance of gas oil) with 0 recycle can result in 35-45% debutanized gasoline, 40% cycle oil, 12% butane—butylene (50% olefin) and 8% C_3 hydrocarbons (60% olefin). Gasoline quality is 94.0-98.0 Research Octane at 3.0 ml/gal TEL. Feed pretreatment of vacuum distillation, decarbonizing, visbreaking or coking might be used.

The several fluid catalytic cracking processes licensed differ primarily in mechanical design. Side-by-side, reactor-regenerator construction along with unitary vessel construction (the reactor either above or below the regenerator) are the two main mechanical variations. From a flow standpoint, all fluid catalytic cracking processes contact hydrocarbon feed and recycle with the finely divided catalyst in the reactor.

Catalyst circulates continuously between the reaction and regeneration zones. Heat of reaction is obtained from the regenerator through the catalyst flow. The catalyst rate is regulated to maintain the required temperature.

Hydrocarbon vapors are separated from the catalyst in the reactor and are sent to conventional fractionation facilities for separation.

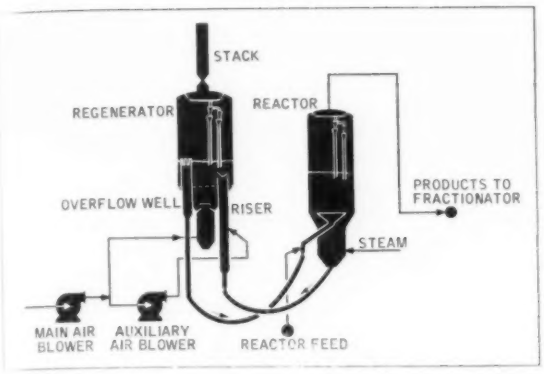
Fluid catalytic cracking was first employed commercially in 1942. Since that time continual improvements in design have made the process the most widely used conversion process in the petroleum industry.

References include:

(1) Bergman, D. J., "How to Instrument a Fluid Catalytic Cracking Unit," *Pet. Ref.*, April 1953, pp. 185-8
(2) Krebs, R. W., "Applications of the Fluid Catalyst Technique to Catalytic Cracking and Hydrocarbon Synthesis," Western Petroleum Refiners Assn., Galveston, Texas, April 1948
(3) MacDonald, M., "Automatic Control of a Fluid Catalytic Cracking Unit," *Pet. Ref.*, Oct. 1946, pp. 87+
(4) Olsen, C. R., and M. L. Sterba, "Effect of Reactor Temperature on Product Distribution and Product Quality in Fluid Catalytic Cracking," *Chem. Engrg. Prog.*, Nov. 1949, pp. 692-700.
(5) Richardson, R. W., F. B. Johnson, and L. V. Robbins, Jr., "Fluid Catalyst Cracking with Silica-Magnesia," *Ind. & Engrg. Chem.* (Ind.), Aug. 1949, pp. 1729+
(6) Thomas, E. J., "Fluid Catalytic Cracking of High Sulfur Stocks with Natural Catalysts," *Oil & Gas J.*, March 23, 1950, pp. 221-8
(7) Thornton, D. P., Jr., "Fluid 'Cat Cracker' Designed to Use New MS Catalyst," PETROLEUM PROCESSING, March 1947, pp. 173-76
(8) Ullrich, W., "How to Start Up a Fluid Cat Cracker," *Pet. Ref.*, Sept. 1955, pp. 214-6
(9) VanDornick, E., "Modern Fluid Catalytic Cracking," *Pet. Engr.*, April 1947, pp. 149+

Model IV Fluid Catalytic Cracking

Licensed by the Esso Research and Engineering Co., New York 19, N. Y., the Model IV design incorporates the most recent engineering modifications. A new catalyst circulation system has resulted in sharp reductions in the over-all size and height of the unit. The Model IV unit is 70% as high as the Model III.



Higher critical velocity is possible in both the regenerator and reactor, making possible the use of smaller diameter vessels for the same charge and capacity. The end result of these modifications is a lowering of steel requirements with a 20% decrease in investment cost.

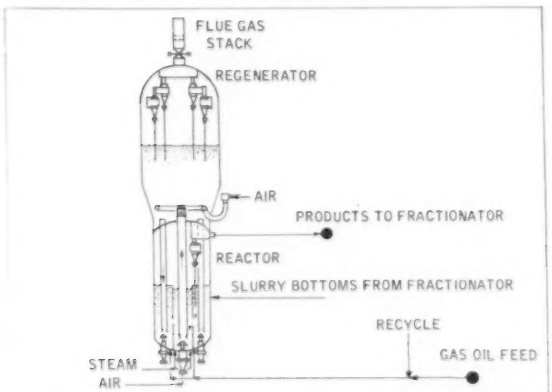
The Model IV low elevation design was preceded by the Model III (1947) balanced pressure design, the Model II (1944) downflow design, and the original Model I (1941) upflow design. The first commercial Model IV installation in the United States was placed on stream in 1952 at the Pan-Am Southern Corp.'s Destrehan, La., refinery.

References include:

(1) McWhirter, W. E., Jr., J. R. Tusson, and H. A. Parker, "Destrehan Model IV Fluid Cat Cracker," *Pet. Ref.*, April, 1956, pp. 201-205
(2) Murphree, E. V., "Progress in Petroleum Technology," American Chemical Society, New York, Sept. 1951
(3) *Oil & Gas J.*, "Model IV Catalytic Cracking," March 19, 1956, p. 138
(4) PETROLEUM PROCESSING, "First Cat Cracker in New England," November 1953, pp. 1689-91
(5) *Pet. Ref.*, "Around the World with Model IV," March 1954, p. 190
(6) *Pet. Ref.*, "Fluid Catalytic Cracking," Sept. 1956, pp. 230-231
(7) Resen, F. L., "Model IV Cracker Proves Itself," *Oil & Gas J.*, March 8, 1954, p. 64
(8) Resen, F. L., "Model IV Cat Cracker Brings Lower Investment, Plus More Efficient Operation to Pan Am Southern at Destrehan," *Oil & Gas J.*, March 22, 1954, pp. 214-222

Available engineering services for Esso Model IV catalytic cracking:
PROC DESIGN: *3, 6,* 8, *17,* 22, 23, *25, 29, 36, 38, 40, 47, 48,* 49, *52, 56, 58, 62, 70*
MECH ENGRG: *3,* 7, 8, *17,* 22, 23, *25, 36, 38, 39, 40,* 47, *48,* 49, *52, 56, 58, 59, 62, 70*
CONSTR: *3, 6, 8, 17,* 22, 23, *25,* 28, *29, 36, 38, 39, 40,* 47, *48,* 49, *52, 56, 58, 59, 62, 70, 79*

Orthoflow Fluid Catalytic Cracking



Licensed by the M. W. Kellogg Co., New York 7, N. Y., its process uses the unitary vessel design and thereby minimizes erosion encountered in pipe bends.

The Orthoflow principle has been commercially successful in two forms—Model A has the regenerator beneath the reactor, Model B has the regenerator above the reactor. Local cost factors usually dictate the choice.

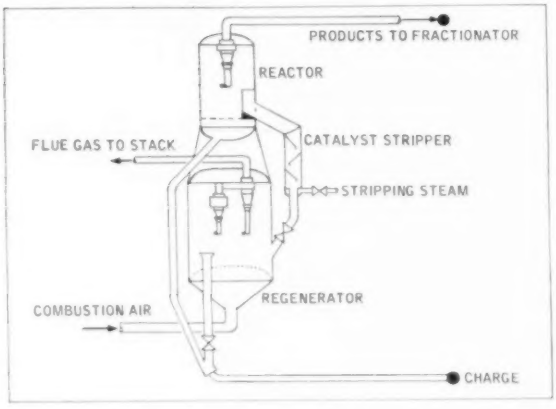
The world's first Orthoflow unit to be put onstream was that of the British-American Oil Co., Ltd., at Edmonton, Alb., Canada.

References include:

(1) *Oil & Gas J.*, "Orthoflow," March 19, 1956, p. 139
(2) *Pet. Ref.*, "Fluid Catalytic Cracking," Sept. 1956, pp. 232-33
(3) *Pet. Ref.*, "Orthoflow Fluid Catalytic Cracking," Sept. 1951, pp. 178-82

Available engineering services for Kellogg Orthoflow catalytic cracking:
PROC DESIGN: *6, 36, 58, 62*
MECH ENGRG: *7, 8, 36, 39, 52, 58, 59, 62*
CONSTR: *6,* 8, 28, *36, 39, 52, 58, 59, 62*

UOP Fluid Catalytic Cracking



Licensed by Universal Oil Products Co., Des Plaines, Ill., this is a fluid process of a unitary reactor-over-regenerator design.

This process is adaptable to the needs of large and small refinery operation. Units having capacities of 1400 to 35,000 barrels per day are in operation.

Important distinguishing features include: (1) Elimination of the air riser with its attendant large expansion joints, (2) elimination of considerable structural steel supports, and (3) reduction in regenerator and in air line size through use of 15-18 psig pressure operation.

The first such unit employing a unified construction was placed on stream by the Aurora Gasoline Co., Detroit, Mich., in June 1947.

References include:

(1) Anderson, N. K., and M. J. Sterba, "Simplified Catalytic Cracking Unit Meets Requirements of Smaller Refiners," *Pet. Ref.*, Dec. 1945, pp. 497-501
(2) Bland, W. F., "Cut Costs on New 3000 B/D Fluid 'Cracker' By Using Unified Reactor-Regenerator," PETROLEUM PROCESSING, Sept. 1947, pp. 670-72
(3) Brown, H. A., and M. J. Sterba, "Raw Crude Oil Is Charged Directly to 2600 B/D Catalytic Cracking Unit," PETROLEUM PROCESSING, Aug. 1949, pp. 878-80
(4) Jacobs, R. W., "Panhandle's 'Kitten Cracker' has 1,250-Bbl. Daily Charge," *Oil & Gas J.*, June 29, 1950, pp. 81-84
(5) Love, F. H., "Old Ocean Refinery Built Especially for Production of Aviation Gasoline," *Pet. Ref.*, Sept. 1945, pp. 51-58
(6) PETROLEUM PROCESSING, "Fluid Cracker Charges Heavy Distillate In Postwar Motor Gasoline Operation," Jan. 1947, pp. 46-48
(7) Read, D., "Midget Fluid-Catalyst Cracker Makes Progress Eco-

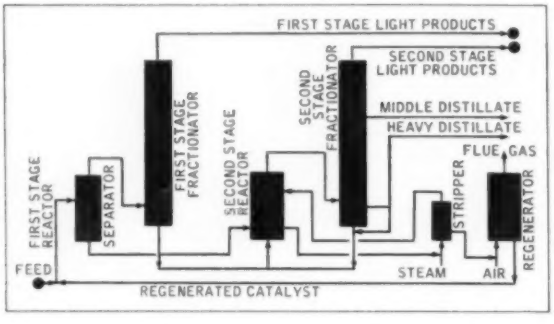
Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

nomical for the Smaller Refinery," *Oil & Gas J.*, April 20, 1946, pp.144-9
(8) Read, D., "Process Systems Applicable to Military Aviation Fuel Manufacture," *Pet. Ref.*, Mar. 1951, pp. 130-31

Available engineering services for UOP fluid catalytic cracking:
PROC DESIGN: 3, 6, 8, 22, 23, *25*, *29*, *32*, *36*, *40*, 47, *48*, 50, 52, 56, 58, 62, 72, 78
MECH ENGRG: *3*, *7*, *8*, *11*, *17*, 21, 22, 23, *25*, 31, *36*, *39*, *40*, 47, *48*, 49, *52*, 58, 59, 62, 66, 70, 72, *73*, 78
CONSTR: *3*, *6*, *8*, *11*, *17*, 21, 22, 23, *25*, 28, *29*, 31, *32*, *36*, *39*, *40*, 47, *48*, 49, *52*, 58, 59, 61, 62, 66, 70, 72, 73, 78, *79*

Shell Fluid Catalytic Cracking



Licensed by the Shell Development Co., Emeryville, Calif., a two-stage fluid catalytic cracking process which permits greater flexibility in shifting product distribution when dictated by demand.

Typified by the flow diagram, virgin feed is first contacted with cracking catalyst in a riser reactor—i.e., a pipe in which fluidized catalyst and vaporized oil flow concurrently upward. Total contact time in this first stage is very short, on the order of seconds. High temperatures (875-1050°F) are employed to reduce undesirable coke laydown on catalyst without destruction of gasoline by secondary cracking. Other operating conditions in the first stage are 16 psig, catalyst-oil ratio 3-50/1. Volume conversion ranges between 20 and 70%.

All or part of the unconverted or partially converted gas-oil product from the first stage is then cracked further in the second-stage fluid bed reactor. Operating conditions herein are 900-1000°F, 16 psig, catalyst-oil ratio is 2-15/1. Conversion in the second stage varies between 15-70%. The overall conversion range therefore is 50-80%.

The first commercial installation came on stream in January 1956 at the Shell Oil Co. Anacortes, Wash., refinery.

Refererences include:

(1) Heldman, J. D., F. Kunreuther, J. A. Marshall, and C. A. Rehbein, "Cat Cracking Now in Two Stages," *Pet. Ref.*, May 1956, pp. 166-170
(2) *Oil & Gas J.*, "Two Stage Cat Cracker Unveiled," May 21, 1956, pp. 131
(3) Petroleum Processing, "More Gasoline and Less Coke," June 1956, pp. 54-7
(4) *Pet. Ref.*, "Fluid Catalytic Cracking," Sept. 1956, pp. 234-5

Available engineering services for Shell 2-stage catalytic cracking:
PROC DESIGN: *6*, *8*, *17*, *23*, *36*, *38*, *48*, 49, *52*, *56*, *58*, *62*
MECH ENGRG: *7*, *8*, *17*, *23*, *36*, *38*, *39*, *48*, 49, *52*, *56*, *58*, *59*, *62*
CONSTR: *6*, *8*, *17*, 23, 28, *36*, *38*, *39*, *48*, 49, *52*, *56*, *58*, *59*, *62*, *79*

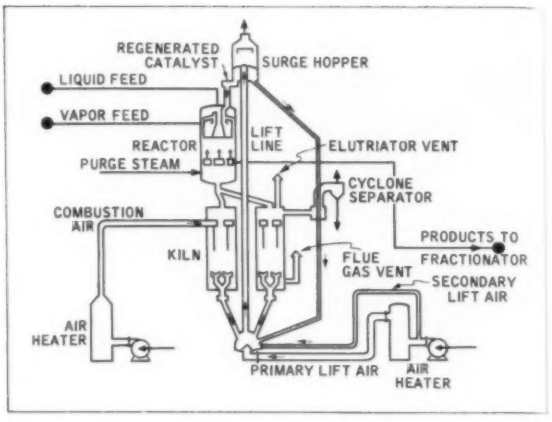
Moving-Bed

Airlift Thermofor Catalytic Cracking

Licensed by Socony Mobil Oil Co., Inc., Airlift TCC is a moving bed, reactor-over-regenerator continuous process for conversion of heavy gas oils into lighter high-quality gasoline and middle distillate fuel oils. Feed preparation normally consists of flashing in a tar separator to get vapor feed. Tar separator bottoms are sent to a vacuum tower from which the liquid feed is produced.

The metal-poisoning resistance of the bead catalyst permits inclusion of some whole crude as reactor charge, and catalyst mechanical strength is good.

Typical feed stock might have a 25.0-30.0°API gravity



and yield: 35-45% debutanized gasoline (at 0-30.0% recycle), of 96.0-98.0 Research Octane at 3.0 ml/gal TEL; 30-40% light and heavy fuel oil; 10-20% butane-butylenes; and 4-5% coke.

Operating conditions are, in the reactor, about 840-920°F, 1.0-2.5/1.0 (v/hr/v) space velocity, 2.0-5.0/1.0 (v/v) catalyst-oil ratio, and 10-15 psig.

Gas oil vapor-liquid flows downward through the reactor concurrent with the regenerated synthetic bead catalyst. The catalytically converted hydrocarbon vapor effluent is sent to the vapor recovery (separation of olefins and iso-butane for polymerization and alkylation charge) and fractionation system (called synthetic crude tower). Catalyst is purged at the base of the reactor and gravitates into the kiln where it is contacted first with low oxygen content flue gas and finally air as it passes countercurrent to the regeneration stream from the top to the base of the kiln. Regenerated, cooled catalyst enters the lift pot where low pressure air transports it to the surge hopper at the top of the reactor for reuse.

The present Airlift TCC unit is a simplification of the original TCC process introduced in 1943. The reactor is now mounted over a simplified kiln and the permissible catalyst-oil ratio has been increased by replacing the bucket elevators with the catalyst air lift. The first commercial Airlift installation was put on stream at the Magnolia Petroleum Co.'s Beaumont, Texas, refinery in October, 1950.

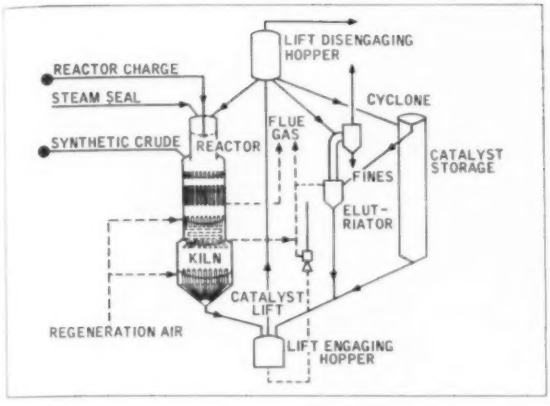
Airlift TCC references include:

(1) Bland, W. F., "Prefabricated Catalytic Cracking Units Now Available in 'Packaged' Form," Petroleum Processing, July 1950, pp. 711-2
(2) Danner, A. V., "Socony-Vacuum TCC Units Move Catalyst by Gas Lift," *Pet. Ref.* Sept. 1950, pp. 179-182
(3) Hamilton, W. W., S. C. Eastwood, A. E. Potas, and E. A. Schraishukn, "Wide Range of Feed Stocks Possible with Airlift TCC," *Pet. Ref.*, Aug. 1952, pp. 71-8
(4) *Pet. Ref.*, "Two New Air-Lift Type TCC Units Put Into Operation," Mar. 1951, pp. 95-96
(5) Thornton, D. P., Jr., "First 'Air-Lift' TCC Unit," Petroleum Processing, Feb. 1951, pp. 146-9
(6) Thornton, D. P., Jr., "How Derby Gained Flexibility With Its New Air-Lift TCC," Petroleum Processing, June 1952, pp. 815-7
(7) Uhl, W. C., "TCC Unit Gives High Liquid Recovery by Operating On Vapor-Liquid Feed," Petroleum Processing, Sept. 1950, pp. 950-52

Available engineering services for Airlift TCC:
PROC DESIGN: *3*, *6*, *8*, *17*, *22*, *23*, *25*, *29*, *36*, 38, *40*, 47, *48*, *49*, *52*, *56*, *58*, *62*, 66, 70
MECH ENGRG: *3*, 7, 8, 11, *17*, *22*, *23*, *25*, *36*, 38, *39*, *40*, 46, 47, *48*, *49*, 51, *52*, *56*, *58*, *59*, *62*, 66, 70, *73*
CONSTR: *3*, *6*, *8*, 11, *17*, *22*, *23*, *25*, 28, *29*, *36*, 38, *39*, *40*, 46, 47, *48*, *49*, *52*, *56*, *58*, *59*, *62*, 66, 70, *73*, *79*

Houdriflow Catalytic Cracking

Licensed by Houdry Process Corp., Houdriflow catalytic cracking is a continuous, moving bed process employing an integrated single vessel for the reactor and regenerator-kiln. Charge stock, sweet or sour, can be any fraction of the crude boiling between naphtha and penetration asphalt. Catalyst is transported from the bottom of the unit to the top in a ga



lift employing compressed flue gas and steam as the motivating vapor.

Houdriflow feed can be liquid, vapor or a mixture of both. Normal operating conditions fall in the range of 850-925°F, 5-10 psig, 1.5-4.0/1.0 (v/hr/v) space velocity, and 3.0-7.0/1.0 (v/v) catalyst-oil ratio.

Reactor feed, emitting from a specially designed nozzle, and catalyst pass concurrently through reactor zone to disengager section wherein vapors are separated and sent to a conventional fractionation system.

Spent catalyst which has been steam purged of residual oil flows to the kiln for regeneration. Steam and flue gas at 6 psig transport catalyst to the lift disengaging hopper from which catalyst is fed to the reactor. Fines are separated continuously from a small portion of the circulating catalyst in the elutriator.

The gas-lift Houdriflow has replaced the bucket type Houdriflow moving-bed operation. The basic present design was first commercially placed on stream at the Sun Oil Co.'s Toledo, Ohio, refinery in May 1950.

Houdriflow references include:

(1) Barton, P. D., "Sun's New Houdriflow Unit," *Oil & Gas J.*, Mar. 29, 1951, pp. 232-4, 322-7
(2) Boynton, F. B., "Producing 90-Octane Gasoline With Houdriflow," *Pet. Ref.*, May 1952, pp. 133-5
(3) Burtis, T. A., J. C. Dart, C. G. Kirkbride, and C. C. Peavy, "Economics of Moving Bed Catalytic Cracking Processes," *Chem. Engrg. Prog.*, Feb. 1949, pp. 97-101
(4) Maerker, J. B., J. W. Schall, and J. C. Dait, "Moving Bed Recycle Catalytic Cracking Correlations," *Chem. Engrg. Prog.*, Feb. 1951, pp. 95-101
(5) Mills, G. A., "Aging of Cracking Catalysts," *Ind. & Engrg. Chem.*, Jan. 1950, p. 182
(6) *Oil & Gas J.*, "Houdriflow Catalytic Cracking," Mar. 21, 1955, pp. 144-5
(7) Peavy, C. C., W. Weinrich, H. D. Noll, and G. F. Hornaday, "Various Refinery Applications of Houdriflow Catalytic Cracking," Western Petroleum Refiners Assn., San Antonio, Mar. 1949—reviewed in PETROLEUM PROCESSING, May 1949, pp. 554-8
(8) PETROLEUM PROCESSING, "A Report on Houdriflow," Feb. 1949, pp. 137-8
(9) Schall, J. W., and J. C. Dait, "Catalytic Cracking of High Nitrogen Charge Stock," *Pet. Ref.*, Mar. 1952, pp. 101-3, & Apr. 1952, pp. 173-6
(10) Stackner, J., "Easier Control by Graphic Panel," PETROLEUM PROCESSING, June 1951, pp. 626-7
(11) Thornton, D. P., Jr., "New Houdriflow Cracking Unit Has High Catalyst-Oil Ratio, Low Preheat Requirements," PETROLEUM PROCESSING, June 1950, pp. 601-5

Available engineering services for Houdriflow catalytic cracking:

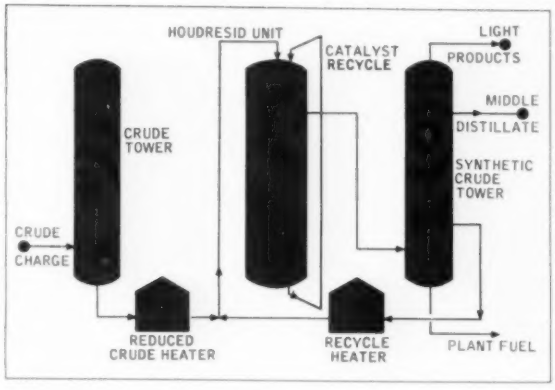
PROC DESIGN: *3, 6,* 11, *22, 23, 25, 29,* 32, 34, *36, 38,* 40, 47, *48, 49, 52, 56, 58, 62, 66, 70, 72*

MECH ENGRG: *3,* 7, *8,* 11, *17, 23, 25,* 34, *36, 38, 39,* 40, 47, *48, 49, 52, 56, 58, 59, 62, 66, 70, 72, 73*

CONSTR: *3, 6, 8,* 11, *17, 23, 25,* 28, *29,* 32, 34, *36, 38, 39,* 40, 47, *48, 49, 52, 56, 58, 59,* 61, *62, 66, 70,* 72, *73,* 76, *79*

Houdresid Catalytic Cracking

Licensed by Houdry Process Corp., Houdresid catalytic cracking is a relatively new variation, using a continuous moving-bed of catalyst to get high yields of high-octane



gasoline and light distillate fuels from reduced crude charge.

Residuum cuts ranging from crude tower bottoms to vacuum bottoms, including residua high in sulfur or nitrogen can be employed as charge over a synthetic or natural catalyst. Though equipment employed is similar in many respects to that employed in Houdriflow units, novel process features modify or eliminate the adverse effects on catalyst and product selectivity heretofore resulting when heavy metals—iron, nickel, copper and vanadium—are present in the fuel.

The Houdresid catalytic reactor and catalyst regenerating kiln are contained in a single vessel. Refinery charge plus recycle gas oil are charged to the top of the unit in a partially vaporized state, and mixed with steam. Hydrocarbon and catalyst flow patterns are similar to that employed in Houdriflow operation.

Coke production (15.0-20.0 wt %) is higher than that of the Houdriflow process when a 7.0-12.0° API heavy residuum with high contaminant concentration is charged. Debutanized gasoline yields of 30-37% were obtained having clear Research Octane values between 89.0-93.0.

The first commercial installation of this process was placed on stream in March 1954 at the Sun Oil Co., Ltd., Sarnia, Ont., Canada.

Houdresid references include:

(1) Bland, R. E., "How Houdresid Works On Heavy Stocks," *Pet. Ref.*, Sept. 1955, pp. 166-8
(2) Dart, J. C., G. A. Mills, A. G. Oblad, and C. C. Peavy, "Houdresid Process Cracks Residua," *Pet. Ref.*, June 1955, pp. 153-6
(3) *Oil & Gas J.*, "Houdresid Catalytic Cracking," Mar. 19, 1956, p. 143
(4) *Oil & Gas J.*, "Houdresid Designed to Convert Entire Bottoms Fraction to Distillates Without Significant Damage to Catalysts," Mar. 28, 1955, pp. 83
(5) *Pet. Ref.*, "Houdresid," Sept. 1956, pp. 238-9

Available engineering services for Houdresid catalytic cracking:

PROC DESIGN: *3, 6,* 11, *23, 25, 29, 32,* 34, *36, 38, 40, 48, 49,* 52, *56, 58, 62, 66, 70,* 72

MECH ENGRG: *3,* 7, *8,* 11, *17 23, 25,* 34, *36, 38, 39, 40, 48, 49, 52, 56, 58, 59, 62, 66, 70, 72, 73*

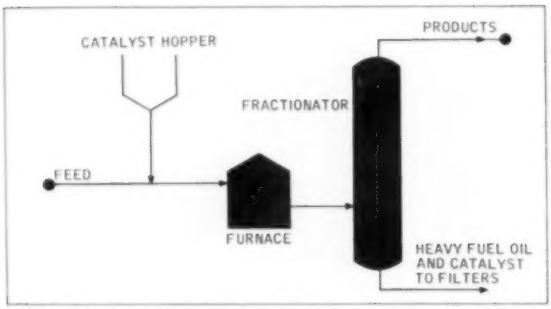
CONSTR: *3, 6, 8,* 11, *17, 23, 25,* 28, *29,* 32, 34, *36, 38, 39,* 40, 47, *48, 49, 52, 56, 58, 59,* 61, *62, 66, 70,* 72, *73,* 76, *79*

Suspensoid Catalytic Cracking

A once through non-regenerative catalytic cracking process in which cracking stock is mixed with a catalyst cycle oil slurry and passed through the coils of a fired heater. No reactor is employed and catalyst is removed from the fractionator bottoms of heavy residual oil through use of Rotary

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.



filters. Straight run naphtha can be included in the charge for upgrading through the reforming mechanisms.

Process is actually a compromise between catalytic and thermal cracking. Main effect of the catalyst is to allow a higher cracking temperature and to assist mechanically in keeping coke from accumulating on the walls of the tubes. The normal catalyst employed is spent clay obtained from the contact filtration of lubricating oils (2-10 lb per barrel of feed). Regular fluid cracking catalyst can be employed resulting in slightly higher gasoline yields of slightly lower octane number, but catalyst recovery and reuse would have to be practiced to justify the expense necessitating more equipment investment. Where spent lube clay is available, use of new or fresh catalyst would be hard to justify economically.

Operating conditions at the coil outlet under "regular" suspensoid operation are 450 psi and 1050°F. Under "super" suspensoid operation the conditions are 250 psi and 1090°F. The latter more severe operation necessitates use of special streamlined heater headers to minimize erosion.

A virgin charge of 35-43°API gravity and containing naphtha of 35-40% resulted in gasoline yields of 50-85% of 85-92 Research octane clear.

The first commercial installation of Suspensoid catalytic cracking was placed on stream at the Imperial Oil Co., Ltd., of Canada refinery at Sarnia, Ontario, in 1940.

References include:

(1) Burk, C. F., "New Developments in Suspensoid Catalytic Cracking," *Oil & Gas J.*, Oct. 8, 1947, pp. 100+
(2) Caesar, C. H., "Catalytic Effects in Suspensoid Cracking," PETROLEUM PROCESSING, Aug., 1949, pp. 887-90
(3) Caesar, C. H., "Suspensoid Catalytic Cracking at Imperial Oil's Sarnia Refinery," *Oil & Gas J.*, Aug. 27, 1947, pp. 69+
(4) Caesar, C. H. "The Suspensoid Catalytic Cracking Process," Canadian Institute of Chemistry, June, 1947, Banff, Canada—reviewed in PETROLEUM PROCESSING, Dec., 1947, pp. 929-930
(5) Foster, A. L., "Suspensoid Catalytic Cracking System Gives Nearly 60% Gasoline Yield," *Oil & Gas J.*, May 4, 1944, p. 43
(6) Purvin, R. L., "Suspensoid Catalytic Cracking," PETROLEUM PROCESSING, May, 1947, pp. 328-31
(7) Sittig, M., "The Suspensoid Process," *Pet. Ref.*, Sept., 1952, p. 312

Available engineering services for Suspensoid catalytic cracking:
PROC DESIGN: *6, 8, 23, 49, 56, 58, 60*
MECH ENGRG: *7, 8, 23, 39, 49, 52, 56, 58, 59*
CONSTR: *6, 8, 23, 28, 39, 49, 52, 56, 58, 59, 79*

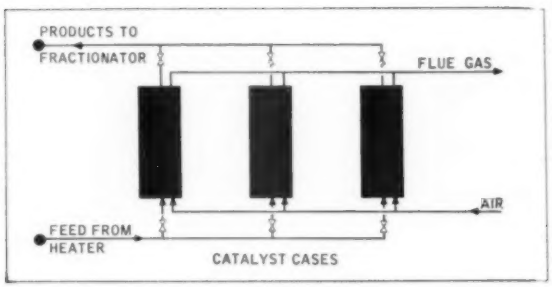
Fixed-Bed

Houdry Fixed-Bed Catalytic Grading

Licensed by Houdry Process Corp., Philadelphia, Pa., this is a fixed bed cyclic regenerable catalytic cracking process for converting distillate charge stocks—virgin or coker gas oils—into yields of gasoline, light and heavy distillates, coke, butanes-butylenes and fuel gas.

Synthetic or natural bead catalyst have been employed and have lasted more than one and a half years. Feed stocks having initial boiling points between 400-450°F and end points of 750-950°F have yielded 35-40% debutanized gasoline of 85.0-87.0 Research octane number, clear. Light and heavy distillate yields ranged between 45-55%. Coke gas and mixed C_4 yields were 10-17%.

Operating conditions in the reactor for a typical feed have been in the range of 840-875°F, 7-30 psig and 1.0-2.0 (v/hr/v) space velocity.



A typical cycle for Houdry Fixed Bed operation is: (1) onstream—10 min., (2) purge—5 min., (3) regeneration—10 min., (4) steam purge—5 min.

Because of the elaborate instrumentation required and because of the economic attractiveness to the large and small refinery operations of the modern moving and fixed bed catalytic cracking processes most of the original Houdry Fixed Bed units have been replaced.

Historically the Houdry Fixed Bed process was the first of the present day catalytic reforming processes. It was preceded only by the McAfee batch process (employed a metallic halide catalyst) which has long since lost commercial significance. The first Houdry Fixed Bed commercial installation was placed on stream by the Socony Vacuum Oil Co. (now Socony Mobil Oil Co.) at Paulsboro, N. J., in June 1936.

References include:

(1) Bates, J. R., F. W. Rose, Jr., S. S. Kurtz, Jr., and I. W. Mills, "Composition of Catalytically Cracked Gasolines," *Ind. & Engrg. Chem.*, Feb. 1942, pp. 147-152
(2) Carey, J. S., and H. W. Artendahl, "Catalytic Cracking Economics Complicate Comparisons," *Nat. Pet. News*, Oct. 16, 1940, pp. R370-5
(3) Evans, J. E., and R. C. Lassiat, "Combustion-gas Turbine in the Houdry Process," *Pet. Ref.*, Nov. 1945, pp. 461-66
(4) Houdry, E. J., W. F. Burt, A. E. Pew, Jr., and W. A. Peters, Jr., "Catalytic Processing of Petroleum Hydrocarbons by the Houdry Process," *Proc. of A. P. I.* (III), 1939, pp. 133-48
(5) Lassiat, R. C., and C. H. Thayer, "Improved Houdry Reactor Design," *Pet. Ref.*, Sept. 1946, pp. 453-6

CATALYTIC REFORMING

A continuous catalytic process to upgrade low-octane virgin or thermal naphthas into high-octane components for motor or aviation fuel blending or petrochemical usage. Volatility is increased and sulfur content is reduced. Octane improvement of virgin naphtha is 20-50 Research Octane numbers, depending upon charge quality and operating severity. Currently an average yield-octane relationship for reforming (excluding aromatic extraction) might be considered as 85.0% debutanized product based upon a 200-400°F virgin charge) yield of 95.0-97.0 Research Octane number (at 3.0 ml/gal TEL).

Of the sixteen individual type processes in use today, two are moving-bed type, two are fluid-bed type, and the remaining are fixed-bed processes. The fluid- and moving-bed processes use mixed non-precious metal oxide catalysts in units equipped with separate regeneration facilities. Fixed bed processes use predominantly platinum-containing catalysts in units equipped for cyclic, occasional, or no regeneration.

Basically, catalytic reforming is the rearranging of molecules in a gasoline boiling range material to give a higher antiknock quality at the expense of gasoline yield.

The primary reaction mechanisms are: (1) dehydrogenation of naphthenes, (2) dehydrocyclization of paraffins, (3) paraffin isomerization, (4) dehydroisomerization of naphthenes, (5) paraffin hydrocracking, (6) desulfurization, and (7) olefin saturation. The hydrocarbon composition of the feed and the selectivity of the catalyst as well as the reforming operating severity—pressure, temperature, space velocity and hydrogen recycle rate—determine the primary hydrocarbon reactions for a given reformer-refinery situation.

Operating conditions are in the ranges of 800-1000°F, 50-750

sig, 0.7-5.0 v/hr/v space velocity, and 3.0-10.0 moles gas/mole naphtha, gas recycle ratio—depending upon the process type and catalyst employed.

Average investment costs for catalytic reforming processes are reported at $150-450/bbl of capacity with operating costs 20-50¢ /bbl, excluding return on investment.

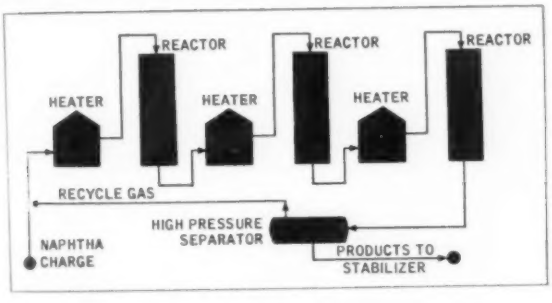
The catalytic reforming process was commercially nonexistent in the United States prior to 1940. Reforming operations during World War II were directed toward production of high octane aviation components as well as chemicals to be employed in the production of explosives.

The rapid growth in the use of catalytic reforming in the refining industry has been phenomenal during the past five years. Current construction announcements indicate that refiners also intend to make full use of catalytic reforming for feed stocks other than virgin naphtha.

General catalytic reforming references include:

(1) Brooks, B. T., C. E. Board, S. S. Kurtz, and L. Schmerling, "The Chemistry of Petroleum Hydrocarbons," Vol. 2, 1955, Reinhold Publishing Corp.
(2) Foster, A. L., "Catalytic Cracking and Reforming," *Petr. Engr.*, July 1956, pp. C-14-18
(3) Hettinger, W. P., Jr., C. D. Keith, J. L. Gring, and J. W. Teter, "Hydroforming Reactions; Effects of Certain Catalyst Properties and Poisons," *Ind. & Engrg. Chem.*, Apr. 1955, pp. 719-30
(4) *Oil & Gas J.*, "Catalysis in Petroleum Refining," Mar. 21, 1955, pp. 148-62
(5) *Oil & Gas J.*, "100 Octane," Mar. 19, 1956, pp. 144-58
(6) Petroleum Processing, "Catalytic Reforming," Aug. 1955, pp. 1157-1204
(7) Sittig, M., "Catalytic Process Mechanics," Petroleum Processing, July 1954, pp. 1048-55
(8) Petroleum Processing, "Trends in Petroleum Refining," May 1949, pp. 560-63
(9) Rushton, J. H., "The Evolution of Hydroforming," *Chem. in Canada*, Nov. 1954, pp. 33-6 & Mar. 1955, pp. 31-5
(10) Steel, R. A., J. A. Bock, W. R. Hertwig, and L. W. Russum, "Selecting a Catalytic Reforming Process," *Petr. Ref.*, May 1954, pp. 167-71
(11) Thomas, R. W., and P. M. Arnold, "Petroleum-Annual Review 1955," *Ind. & Engrg. Chem.*, Jan. 1956, pp. 40-1A
(12) Vener, R. E., "Moving Bed Processes," *Chem. Engrg.*, July 1955, 173-206

Fixed-Bed—No Swing Reactor



Fixed-bed, continuous catalytic reforming processes use an acid-type, pelleted catalyst containing platinum (0.01-1.0%) averaging approximately 0.5% on alumina or silica-alumina carrier. A pretreatment or guard case may be installed to insure against catalyst contamination by arsenic, lead, copper, nitrogen, water and sulfur.

Typical virgin naphtha feed has an initial boiling point of 175-250°F and a final boiling point of 350-400°F, and is generally obtained from a prefractionator. The feed is added to a heater together with recycle gas (3.0-10.0 moles of H_2 per mole of liquid feed) containing Hydrogen of 80-98% purity.

The temperature of 850-950°F is held by inter-reactor heaters to compensate for the endothermic reforming reaction. The pressure in the reactor is held at about 500 psig, though pressures in the range of 300-750 psig may be used, depending upon feed composition and boiling range and catalyst activity. Higher pressures are used to extend catalyst life when charging high boiling stocks. Lower pressures favor dehydrogenation of naphthenes to aromatics and reduce hydrocracking. The space velocity (vol/hr/vol) is usually 1.0-5.0

Except for the Platforming process, the processes described under this heading do have facilities for *in situ* regeneration of the catalyst under blocked-out operating conditions. Such regeneration is usually necessitated by prolonged high-severity operation or process upsets. Regeneration in the case of Platforming is said to be possible, but economically unjustifiable.

Catforming

Licensed by the Atlantic Refining Co., Philadelphia, Pa., the main feature of this process which differentiates it from the other reforming processes in this category is the catalyst composition. The Catalyst, produced by the Davidson Chemical Corp., is a platinum, silica-alumina composition which permits relatively high space velocities and results in very high hydrogen purity. Regeneration to prolong catalyst life is practiced on a blocked out basis with a dilute air-in-steam mixture. McBride Oil and Gas Corp. at LaBlanca, Texas, placed the first Catforming unit on stream in August 1952.

Catforming references include:

(1) Connor, J. E., Jr., F. G. Ciapetta, L. N. Leum, and M. J. Fowle, "Benzene Production Over the Platforming Catalyst," *Ind. & Engrg. Chem.*, Jan. 1955, pp. 152-6
(2) Fowle, M. J., R. D. Bent, F. G. Ciapetta, P. M. Pitts, and L. N. Leum, "Development of a Reforming Catalyst," Advances in Chemistry Series—No. 5, 1951, pp. 76-82
(3) Fowle, M. J., R. D. Bent, and G. P. Masologites, "Tomorrow's Octanes," American Petroleum Inst., San Francisco, Calif., May 1952
(4) Fowle, M. J., R. D. Bent, B. E. Milner, and G. P. Masologites, "In Reforming—It's the Catalyst that Counts," *Pet. Ref.*, Apr. 1952, pp. 156-9
(5) Milner, B. E., "Atlantic Catforming," California Natural Gasoline Assn., Nov. 1953
(6) Milner, B. E., "Catforming for Octanes," *World Pet.*, Jan. 1953, pp. 50-51
(7) Milner, B. E., H. H. Logan, Jr., J. A. Nevison, "Catforming at United Refining Company," *Pet. Ref.*, Sept. 1955, pp. 169-73
(8) Petroleum Processing, "Catforming," Aug. 1955, pp. 1182-3
(9) Petroleum Processing, "39% Benzene Yield From a C_6 Straight-Run Fraction," Mar. 1951, pp. 249-50
(10) Thornton, D. P., Jr., "How a Small Plant Makes Octanes," Petroleum Processing, Aug. 1953, pp. 1159-61
(11) Worrell, G. R., "Now 100 Octane from Natural Gasoline," *Pet. Ref.*, Apr. 1956, pp. 138-40

Available engineering services for Catforming:
PROC DESIGN: *3*, 6, *8*, *17*, *22*, *23*, *25*, 29, 33, *36*, *38*, *40*, 46, 47, *48*, *49*, *51*, 52, 56, *58*, 60, *62*, *66*, 70, *72*
MECH ENGRG: *3*, 6, 7, *8*, *17*, 19, *22*, *23*, *25*, *36*, *38*, *39*, *40*, 46, 47, *48*, *49*, *51*, 52, 56, *58*, *59*, *62*, *66*, 70, *72*, 73
CONSTR: *3*, 6, *8*, *17*, 19, *22*, *23*, *25*, 28, 29, *36*, *38*, *39*, *40*, 46, 47, *48*, *49*, 52, 56, *58*, *59*, *62*, *66*, 70, *72*, 73, *79*

Houdriforming

Licensed by The Houdry Process Corporation, Philadelphia, Pa. Catalyst may be regenerated if necessary on a block-out basis. A "guard case" catalytic hydrogenation pretreating stage using the same Houdry Type 3 catalyst (manufactured by the Houdry Process Company) as the Houdriformer reactors—is available for high sulfur feed stocks. Lead and copper salts are also removed under the mild conditions of the guard case operation. The first commercial Houdriformer was placed on-stream in November 1953 at Marcus Hook, Pa., by the Sun Oil Co.

Houdriforming references include:

(1) Beyler, D., D. H. Stevenson, and F. R. Shuman, "Houdriforming for Aromatics," *Ind. & Engrg. Chem.*, Apr. 1955, pp. 740-44
(2) Bland, R. E., "Houdriforming," *Pet. Engr.*, Apr. 1954, pp. C-18-21
(3) Burtis, T. A., and H. D. Noll, "Houdriforming—Its Place in the

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

Refining of Petroleum," Western Petroleum Refiners Assn., San Antonio, Texas, Apr. 1952
(4) Dart, J. C., A. G. Oblad, and J. W. Schall, "Houdriforming at Low Pressure," American Petroleum Inst., San Francisco, Calif., May 1952—reviewed in PETROLEUM PROCESSING, June 1952, pp. 842
(5) Heinemann, H., J. B. Hattman, and J. W. Schall, "Houdriforming of Hydrocracked Naphthas; Composition of Naphthas from Gas Oil Hydrocracking," *Ind. & Engrg. Chem.*, Apr. 1955, pp. 735-9
(6) Heinemann, H., G. A. Mills, J. B. Hattman, and F. W. Kirsch, "Houdriforming Reactions—Studies with Pure Hydrocarbons," *Ind. & Engrg. Chem.*, Jan. 1953, pp. 130-33
(7) Heinemann, H., J. W. Schall, and D. H. Stevenson, "Application of Houdriforming to Produce Aromatics and High-Octane Motor Gasoline," American Inst. of Chem. Engrs., Galveston, Texas, Oct. 1951
(8) Heinemann, H., J. W. Schall, and D .H. Stevenson, "Houdriforming for Aromatics," *Pet. Engr.*, Dec. 1951, pp. C-40-42
(9) Kirkbride, C. G., "Houdriforming—A New Continuous Process for Reforming Petroleum Naphthas," PETROLEUM PROCESSING, June 1951, pp. 603-6
(10) Mills, G. A., H. Heinemann, T. H. Milliken, and A. G. Oblad, "Catalytic Mechanism (Houdriforming Reactions)," *Ind. & Engrg. Chem.*, Jan. 1953, pp. 134-7
(11) Noll, H. D., "What to Reform and How," *Houdry Pioneer*, Mar. 1953
(12) Noll, H. D., T. A. Burtis, and J. C. Dart, "Houdriforming Economics—Effect of Feed-Stock Boiling Range and Reforming Severity," American Petroleum Inst., New York, N. Y., May 1953
(13) PETROLEUM PROCESSING, "Houdriforming," Aug. 1955, pp. 1178-9
(14) Stevenson, D. H., and G. A. Mills, "Hydropretreatment of Catalytic Reformer Feed," American Petroleum Inst., St. Louis, Mo., May, 1955

Available engineering services for Houdriforming:
PROC DESIGN: *3*, 6, 8, 11, *17*, *23*, *25*, *29*, 32, 33, 34, *36*, 38, *40*, 46, 47, *48*, *49*, 52, *56*, *58*, 62, *70*, 72
MECH ENGRG: *3*, 6, 7, 8, 11, 17, 19, 23, 25, 34, 36, 38, 39, 40, 46, 47, 48, 49, 52, 56, 58, 59, 62, 70, 72, 73
CONSTR: *3*, 6, 8, 11, *17*, *19*, *23*, *25*, 28, *29*, 32, 33, 34, *36*, 38, *39*, *40*, 46, 47, *48*, *49*, *52*, *56*, *58*, *59*, 61, 62, *70*, 72, *73*, *79*

Platforming

Licensed by Universal Oil Products Co., Des Plaines, Illinois. The platinum-alumina catalyst produced by Universal Polychem Co. includes a combined halogen—0.1-8.0% of fluorine or chlorine based on alumina. To guard against plant upsets, the feed is usually held at a 375°F end point. No regeneration is practiced and reaction is carried out at 700-750 psig. The first unit went onstream at the Old Dutch Refining Co. (now Aurora Gasoline Co.) refinery at Muskegon, Mich. in October 1949. This was the first commercial reforming process using a platinum-containing catalyst.

Platforming references include:

(1) Bland, W. F., "Platforming," PETROLEUM PROCESSING, Apr. 1950, pp. 351-5
(2) Bogen, J. S., and V. Haensel, "Platformate—Properties and Performance," American Petroleum Institute, May 1950
(3) Cox, R. F., and R. H. Killgore, "Natural Gasoline Plant Platformer," PETROLEUM PROCESSING, Nov. 1956, pp. 102-7
(4) Donaldson, G. R., and V. Haensel, "Platforming Reactions of Pure Hydrocarbons," *Ind. & Engrg. Chem.*, Sept. 1951, pp. 102-04
(5) Donaldson, G. R., L. F. Pasik, and V. Haensel, "Dehydrocyclication in Platforming," *Ind. & Engrg. Chem.*, Apr. 1955, pp. 731-35
(6) Egloff, G., "The Platforming Process," *J. Inst. of Pet.*, Mar. 1955, pp. 69-79
(7) Foster, A. L., "New Platformer Improves Octane Rating," *Pet. Engr.*, Feb. 1952, pp. C-39-42
(8) Gerald, C. F., "Unifining—Platforming In One Unit," *Pet. Ref.*, May 1956, pp. 216-7
(9) Haensel, V., "Platforming," Western Petroleum Refiners Assn., San Antonio, Texas, Mar. 1950—reviewed in PETROLEUM PROCESSING, Apr. 1950, pp. 356-60
(10) Haensel, V., and C. V. Berger, "Aromatics By Platforming," PETROLEUM PROCESSING, Mar. 1951, pp. 264-7
(11) Haensel, V., and G. R. Donaldson, "How Paraffin Content Effects Quality of Motor Fuels from Platforming," PETROLEUM PROCESSING, Feb. 1953, pp. 236-40
(12) Kastens, M. L., and R. Sutherland, "Platinum Reforming of Gasoline," *Ind. & Engrg. Chem.*, Apr. 1950, pp. 582-93
(13) PETROLEUM PROCESSING, "New Catalytic Reforming Process Shows High Octane Gain, Low Volume Loss," May 1949, pp. 553-5
(14) PETROLEUM PROCESSING, "Penex-Platforming of Naphthas," Aug. 1956, pp. 66-7
(15) PETROLEUM PROCESSING, "Platforming," Aug. 1955, pp. 1176-7
(16) Read, D., and P. C. Weinert, "100 Octane Gasoline By Once Through Platforming," *Oil & Gas J.*, Apr. *23*, 1956, pp. 105-8
(17) Sutherland, R. E., and D. D. Hanson, "Platforming Natural Gasoline," *Oil & Gas J.*, Apr. 1950, pp. 177-8
(18) Weinert, P. C., M. J. Sterba, V. Haensel, and H. W. Grote, "Three Years of Commercial Platforming," American Petroleum Inst., San Francisco, Calif., May 1952

Available engineering services for Platforming:
PROC DESIGN: *3*, 5, 6, 8, 22, 23, *25*, *29*, *32*, *36*, 40, 47, *48*, 49, *52*, 56, 62, 72, 78
MECH ENGRG: *3*, 6, 7, 8, *11*, *14*, *17*, 19, 21, 22, 23, *25*, *32*, *36*, *39*, 40, 46, 47, *48*, 49, *52*, *56*, 58, 59, 62, 66, 70, 72, *73*, 78
CONSTR: *3*, 6, 8, *11*, *14*, *17*, 19, 21, 22, 23, *25*, 28, *29*, *36*, *39*, 40, 46, 47, *48*, 49, *52*, *56*, 58, 59, 61, 62, 66, 70, 72, *73*, *79*

Sinclair-Baker

Arrangements for the use of the Sinclair Baker RD-150 catalyst can be made through Baker and Company or the M. W. Kellogg Company. The RD-150 catalyst (produced by Baker and Company) contains about 0.6 wt. % platinum on alumina. This catalyst has a high ratio of paraffin cyclization activity to hydrocracking activity and has the ability to be regenerated with dilute air. The Pure Oil Co. refinery at Heath, Ohio, and the Sinclair Refinery at Marcus Hook, Pa., were the sites of the first commercial use of Sinclair-Baker reforming.

Sinclair-Baker references include:

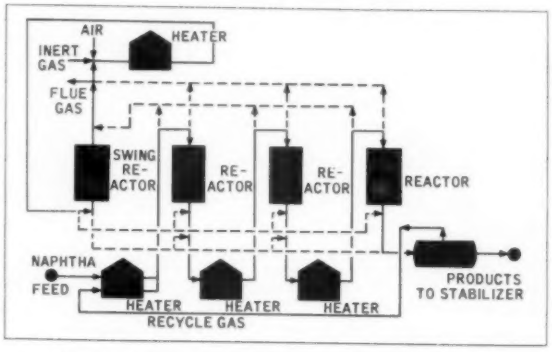
(1) Decker, W. H., "Sinclair-Baker Reforming," *Pet. Engr.*, Apr. 1954, pp. C-30-32
(2) Decker, W. H., and D. Stewart, "Cat Reforming With In-Place Regeneration," *Oil & Gas J.*, July 4, 1955, pp. 80-84
(3) PETROLEUM PROCESSING, "Sinclair-Baker," Aug. 1955, pp. 1186-7
(4) *Pet. Ref.*, "Catalytic Reforming," Sept. 1954, pp. 16-17
(5) Teter, J. W., B. T. Borguson, and L. H. Beckberger, "Sinclair's 'Cat' Reforming Process," PETROLEUM PROCESSING, Oct. 1953, pp. 1519-23
(6) Teter, J. W., and L. E. Olsen, "Research for Sinclair—Baker Catalytic Reforming," *World Pet.*, July 15, 1953, pp. 99-103

Available engineering services for Sinclair-Baker Catalytic Reforming:
PROC DESIGN: 8, *17*, *22*, *23*, *25*, 38, 48, 49, 52, *56*, *58*, *62*, *66*
MECH ENGRG: 7, 8, *17*, *22*, *23*, *25*, *38*, *39*, 48, 49, 52, 55, *58*, *59*, *62*, *66*, 73
CONSTR: 8, *17*, *22*, *23*, *25*, 28, *38*, *39*, 48, 49, 52, *56*, *58*, *59*, *62*, *66*, 73, *79*

Covaforming

Unlicensed process developed and used by the Socony Mobil Oil Co., Inc. This three-reactor, fixed-bed, catalytic reforming process uses the Sinclair-Baker RD-150 catalyst manufactured by Baker & Co. Very few process details have been published for this process. The first commercial installation was placed onstream in November 1954 by the General Petroleum Corp. at Ferndale, Wash.

Fixed-Bed—Swing Reactor



Typical fixed-bed catalytic reforming—with swing reactor

Fixed-bed, continuous, catalytic reforming can be classified by catalyst-type: (1) cyclical regenerative with non-precious metal oxide catalysts, and (2) cyclical regenerative with platinum-alumina catalysts. Both types use swing reactors to regenerate a portion of the catalyst while the remainder stays onstream.

Cyclical regenerative, fixed-bed operation using platinum catalyst is basically a low pressure operation—250-350 psig. The low pressure process gives: (1) higher gasoline yields

cause of fewer hydrocracking reactions, (2) higher product tane from a given naphtha charge, and (3) better hydrogen ields because of more dehydrogenation and less hydrocracking actions.

Coke yield with attendant catalyst deactivation increases apidly at low pressures. Cyclic regeneration affords operating lexibility to realize the advantages of low pressures while controlling the higher coke yield.

Investment costs are higher than the non-regenerative, fixed-bed processes, as an extra, or swing, reactor is needed. An additional pretreat reactor for desulfurization or hydrogenation of a cracked feed might also be needed.

The noticeable feature which differentiates these processes from the previously discussed non-regenerative processes is the swing reactor principle which permits regeneration with no interruption of onstream time.

Fixed-Bed Hydroforming

Developed by Esso Research and Engrg. Co. in conjunction with Standard Oil Co. (Ind.) and the M. W. Kellogg Co. Licensed by the M. W. Kellogg Co., New York, N. Y. This was the first commercial process developed specifically for catalytic reforming. The first unit went onstream in November 1940 at the Pan American Refining Co. (now American Oil Co.) refinery in Texas City, Texas. The catalyst consists of 9.0% molybdenum oxide deposited on activated alumina granules or pellets. The process is cyclic in that two of the four catalyst cases are regenerated while the remainder are on the process cycle. The reaction takes place at about 1000°F, 50-150 psig and 0.5-1.0 v/hr/v space velocity. Products include a hydrogen rich off gas, 400°F end point gasoline component and a high boiling aromatic polymer. These units were used to produce toluene and aromatics for aviation gasoline during World War II, but none have been constructed since the war. Some existing units have been converted to platinum catalyst usage.

Fixed-bed hydrofoming references include:

(1) Armistead, G., Jr., "The Hydroforming Process," *Oil & Gas J.*, Apr. 1946, pp. 85-7
(2) Greensfelder, B. S., R. C. Archibald, and D. L. Fuller, "Catalytic Reforming," *Chem. Engrg. Prog.*, Oct. 1947, pp. 561-8
(3) *Pet. Ref.*, "Hydroforming," Sept. 1952, pp. 14-15
(4) Steiner, H., "Aromatics From Petroleum," *J. of the Inst. of Pet.*, July 1947, pp. 410-35
(5) Swift, J. J., S. R. Stiles, E. W. Howard, and M. Tarnpoll, "Aromatics Recovery," PETROLEUM PROCESSING, Jan. 1953, pp. 81-7
(6) Webb, G. M., M. A. Smith, and C. H. Ehrhardt, "Chemical and Physical Properties of Alumina-Molybdena Oxide Catalyst for Hydroforming," PETROLEUM PROCESSING, Nov. 1947, pp. 834-42

Powerforming

Licensed by the Esso Research and Engineering Co. The platinum catalyst is manufactured by Davison Chemical Co. Four to six reactors are used—three to five are onstream while one is being regenerated by a special technique simulating the swing reactor principle. The cycle on any one reactor is 5-15 days. A hydrogenation pretreat may be employed if warranted. The first commercial Powerforming installation was placed onstream in July 1955 at Baltimore, Md. by the Esso Standard Oil Co.

Powerforming references include:

(1) *Oil & Gas J.*, "Powerforming," Mar. 19, 1956, pp. 150
(2) PETROLEUM PROCESSING, "Powerforming is No. 14," Apr. 1956, pp. 69
(3) *Pet. Ref.*, "Powerforming," Sept. 1956, pp. 212-3

Available engineering services for Powerforming:
PROC DESIGN: 3, *6*, 8, *13*, *17*, 22, 23, *25*, 38, *40*, 47, *48*, 49, 52, *58*, *62*, *66*, *70*
MECH ENGRG: 3, *6*, 7, 8, *13*, *17*, 22, 23, *25*, *38*, *39*, *40*, 47, *48*, *49*, 52, *58*, *59*, *62*, *66*, *70*
CONSTR: 3, *6*, 8, *17*, 22, 23, *25*, 28, *38*, *39*, *40*, 47, *48*, 49, 52, *58*, *59*, *62*, *66*, *70*, *79*

SBK-Catalytic Reforming

Licensed by Baker & Co. or the M. W. Kellogg Co. Employs, if warranted, a desulfurization reactor which also removes metal contaminants. Four platinum containing reforming reactors are used, with the last two run in parallel, either one of which can be regenerated separately without shut-down of the process. Total operating cost, excluding return on investment, ranges between 25-35¢ bbl. The Pure Oil Co. at Heath, Ohio, placed the first commercial unit onstream in September 1954.

SBK Catalytic Reforming references include:

(1) PETROLEUM PROCESSING, "Kellogg Sinclair-Baker," Aug. 1955, pp. 1196
(2) *Pet. Ref.*, "SBK Catalytic Reforming," Sept. 1956, pp. 214-5
(3) Stanford, G. W., "First Kellogg—Designed Cat Reformer," *Pet. Ref.*, Sept. 1955, pp. 190-2

Available engineering services for SBK catalytic reforming:
PROC DESIGN: *58*
MECH ENGRG: *7*, *39*, *52*, *58*, *59*
CONSTR: *28*, *39*, *52*, *58*, *59*

Ultraforming

Licensed by Standard Oil Co. (Indiana), Chicago 80, Ill. Low pressure reforming over a platinum catalyst (0.6%) on an alumina carrier. Catalyst is manufactured by American Cyanamid Co. Regeneration of catalyst in the swing reactor restores catalyst activity without shutting down the unit. Reformate of over 100 research octane, clear, has been obtained from Gulf Coast naphtha charge in the commercial unit at a C_5+ yield of about 78.0 vol %. Heavy aromatic polymer (460-700+°F) included in this yield is about 2.6 vol %. The first commercial installation of Ultraforming went onstream in May 1954 at the Pan-Am Southern Corp. refinery in El Dorado, Ark.

Ultraforming references include:

(1) Birmingham, W. J., "Ultraforming," *Pet. Engr.*, Apr. 1954, pp. C-35-8
(2) Forrester, J. H., A. L. Conn, and J. B. Malloy, "Ultraforming, a Standard of Indiana Development," *Oil & Gas J.*, Apr. 1954, pp. 139-42
(3) Moore, T. M., "Ultraformer Tops 100 Octane," *Pet. Ref.*, Sept. 1955, pp. 174-8
(4) PETROLEUM PROCESSING, "Ultraforming," Aug. 1955, pp. 1184-5
(5) Roberts, J. K., E. W. Thiele, and R. V. Shankland, "Regenerative Platinum-Catalyst Reforming of Naphthas," Fourth World Petroleum Congress, Rome, Italy, June 1955
(6) Steel, R. A., J. A. Bock, W. R. Hertwig, and L. W. Russum, "Selecting a Catalytic Reforming Process," *Pet. Ref.*, May 1954, pp. 167-71
(7) White, P. C., W. F. Johnston, and W. J. Montgomery, "Ultraform to Get 100 Octane, Clear," *Pet. Ref.*, May 1956, pp. 171-77

Available engineering services for Ultraforming:
PROC DESIGN: 3, *6*, *8*, *17*, 22, 23, *25*, 38, *40*, 47, *48*, 49, 52, *56*, 58, 62, *66*, *72*
MECH ENGRG: 3, *6*, 7, *8*, *17*, 22, 23, *25*, *38*, *39*, *40*, 47, *48*, 49, 52, *56*, 58, *59*, *62*, *66*, *72*, *73*
CONSTR: *6*, *8*, *17*, *22*, *23*, *25*, 28, *38*, *39*, *40*, 47, *48*, 49, 52, *56*, 58, *59*, *66*, *72*, *73*, *79*

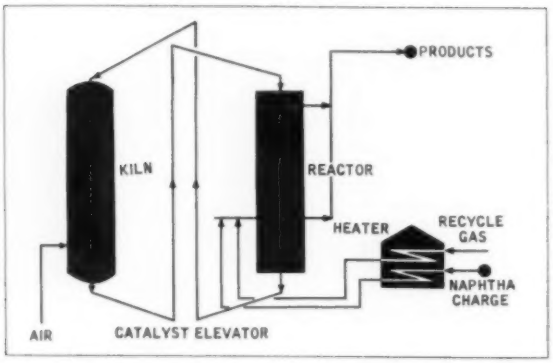
Moving-Bed Reforming

A process employing a single, moving-catalyst-bed reactor with continuous catalyst regeneration. The catalyst is a non-precious metal oxide mixture in bead or pellet form which is transported between reactor and regenerator through use of mechanical or other means.

Depending upon catalyst type, typical feed stock for motor gasoline usage has an initial boiling range of 150-175°F and an end point range of 400-500°F. Aromatic operation would require tailored narrow cuts. Feed stock preparation is nor-

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.



Typical moving-bed catalytic reforming unit

mally not a factor unless water has an adverse effect on the catalyst and then drying is easily adaptable to the recycle gas stream.

Hyperforming

Licensed by the Union Oil Co. of Calif., Patent Div., Research Dept., Brea, Calif. Catalyst pellets of cobalt molybdate with a silica-stabilized alumina base are made by the Harshaw Chemical Co. of Cleveland, Ohio.

The catalyst moves downward through the reactor with gravity flow and is returned to the top of the reactor by means of a unique solids-conveying technique called Hyperflow, which moves catalyst at very low velocities at a minimum attrition loss. Feed naphtha vapor and recycle gas flow upward, countercurrent to catalyst. Regeneration of catalyst is accomplished either in an external vertical lift line or a separate vessel.

Hyperforming virgin naphtha and/or cracked naphtha feed (150-450°F) can result in 40-50 clear Research Octane numbers improvement for the motor fuel component. Sulfur and nitrogen removal are also accomplished. Light gas oil stocks can also be charged to remove sulfur and nitrogen under mild hydrogenation conditions for market as premium diesel fuels and middle distillates.

Operating conditions in the reactor are 400 psig and 800-900°F, the higher temperature being employed for straight run naphtha feed. Investment costs are estimated to be $200-350/bbl of feed capacity.

The first commercial Hyperforming unit was placed on stream in May 1955 at Calstate Refining Co.'s Signal Hill, Calif. refinery.

Hyperforming references include:

(1) Berg, Clyde, "The Design of Hyperforming Units," *Pet. Ref.*, Oct. 1954, pp. 153-7
(2) Berg, Clyde, "Hyperforming," PETROLEUM PROCESSING, July 1953, pp. 1018-23
(3) Berg, Clyde, "Hyperforming Makes Its Bow," *Oil & Gas J.*, Mar. 23, 1953, pp. 286-93
(4) Berg, Clyde, "Hyperforming—Newest Development in Reforming," *Pet. Ref.*, Dec. 1952, pp. 131-6
(5) Berg, Clyde, "Mechanical Features of the Hyperforming Process," Mech. Engrg., Jan. 1955, pp. 19-22
(6) Berg, Clyde, "Signal Hill, California, Plant Gets First Commercial Hyperformer. Operating Cost—12 cents per barrel," *Oil & Gas J.*, Aug. 2, 1954, pp. 91-2
(7) Berg, Clyde, "Union's Cobalt Molybdate Process for Refining High Sulfur Stocks," Oil Sands Project Conf., Canada, Sept. 1951 reviewed in PETROLEUM PROCESSING, Feb. 1952, pp. 186-9
(8) PETROLEUM PROCESSING, "*Hyperforming*," Aug. 1955, pp. 1194-95
(9) PETROLEUM PROCESSING, "New Lift Method for Moving Solids," July 1953, pp. 1024-25

Available engineering services for Hyperforming:
PROC DESIGN: *6, 8, 17, 23, 25, 40, 48, 49, 56, 58, 62, 66*
MECH ENGRG: *6, 7, 8, 17, 23, 25, 39, 40, 48, 49, 52, 56, 58, 59, 62, 66*
CONSTR: *6, 8, 17, 23, 25, 28, 39, 40, 48, 49, 52, 56, 58, 59, 62, 66, 79*

Thermofor Catalytic Reforming

Licensed by Socony Mobil Oil Co., Inc., New York, N. Y. The catalyst, a synthetic bead type of co-precipitated chromia and alumina, is manufactured by the Socony Mobil Co., Inc., in Paulsboro, N. J.

Normal operating conditions in the reactor are 950-1000°F, 100-200 psig, and 0.7 space velocity (v/hr/v). Catalyst flows down through the reactor counter-current and co-current with the naphtha-recycle gas feed which enters the center of the reactor. The catalyst is transported from the base of the reactor to the top of the regenerator by bucket-type elevators. Reformate yields of C_5+ reformate (based on 170-400°F charge) have clear research octane numbers of 85-95. Drying of recycle gas is practiced to prevent reduction in catalyst activity due to moisture content of feed.

Reformate is normally rerun to remove a small volume of heavy aromatic polymer formed (about 2.0 vol %).

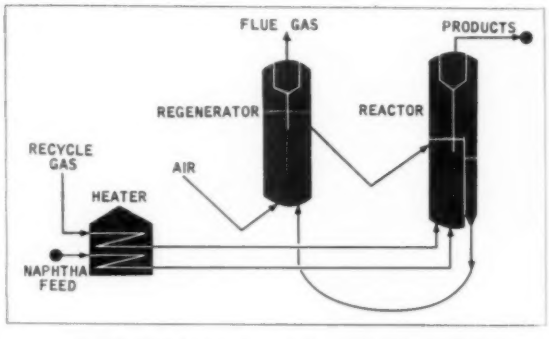
The first commercial unit was put onstream at General Petroleum Corp.'s Torrance, Calif., refinery in March 1955.

TCR references include:

(1) *Chem. Engrg.*, "Thermofor Catalytic Reformer to Make High Octane Gasoline," Aug. 1952, pp. 242-4
(2) Dalton, S. D., and T. P. Simpson, "Catalytic Cracking and Reforming Processes for Increasing the Yield and Octane Number of Gasoline," *Proc. of the Third World Pet. Congress*, The Hague, May-June 1951
(3) Hughes, E. C., H. M. Stine, H. A. Strecker, S. C. Eastwood, C. L. Gutzeit, W. A. Stover, and S. J. Wantuck, "Co-gelled Chromia-Alumina Catalysts for Naphtha Reforming—II. Evaluation of Hydrocarbon Types and Naphthas," International Congress of Pure and Applied Chem., New York, N. Y., Sept. 1951
(4) *Oil & Gas J.*, "Thermofor Catalytic Reforming—An Answer to Demand for Higher Octane Numbers," Nov. 17, 1952, pp. 357-68
(5) *Oil & Gas J.*, "Thermofor Catalytic Reforming Flow Diagram," Mar. 21, 1956, pp. 142-3
(6) Payne, J. W., L. P. Evans, E. V. Bergstrom, and V. O. Bowles, "Thermofor Catalytic Reforming," American Petroleum Inst., San Francisco, Calif., May 1952—reviewed in PETROLEUM PROCESSING, July 1952, pp. 966-9
(7) PETROLEUM PROCESSING, "Moving Bed Catalytic Reforming," June 1951, pp 601-2
(8) PETROLEUM PROCESSING, "Thermofor Catalytic Reforming," Aug. 1955, pp. 1192-3
(9) PETROLEUM PROCESSING, "Thermofor Catalytic Reforming," P.D.S. No. 13, Dec. 1956, pp. 73-5
(10) *Pet. Ref.*, "Thermofor Catalytic Reforming," Sept. 1956, pp. 216-7

Available engineering services for Thermofor Catalytic Reforming:
PROC DESIGN: *3, 6, 8, 17, 23, 25, 38, 40, 47, 48, 49, 52, 56, 58, 62, 66, 70*
MECH ENGRG: *3, 6, 7, 8, 9, 17, 23, 25, 38, 39, 40, 47, 48, 49, 51, 52, 56, 58, 59, 62, 66, 70, 73*
CONSTR: *3, 6, 8, 17, 23, 25, 28, 39, 40, 47, 48, 49, 52, 56, 58, 59, 62, 66, 70, 73, 79*

Fluid-Bed Reforming



Typical fluid-bed catalytic reforming unit

In catalytic reforming processes using a fluidized-solids catalyst-bed, continuous regeneration with a separate or integrated reactor is practiced to maintain catalyst activity by coke and sulfur removal. Cracked or virgin naphthas are charged with hydrogen rich recycle gas to the reactor. A molybdena (10.0%) on alumina catalyst—not materially affected by normal amounts of arsenic, iron, nitrogen or sulfur—is used.

Operating conditions in the reactor are about 200-300 psig, 900-950°F at a space velocity of 0.3-0.8 (w/hr/w). In the regenerator, 210-310 psig and 1000-1100°F conditions are used

ed stock preparation, except for tailoring the boiling range or aromatic production, normally is not practiced.

Fluidized bed operation with its attendant excellent temperature control prevents over and under reforming operations, resulting in more selectivity in the conditions needed for optimum yield of the desired product.

Reforming severities resulting in yields of 70.0-80.0 vol % reformate (C_5+) may have clear Research Octane numbers of 98.0-93.0. Installation costs, depending on unit size, vary between $200-400/bbl of charge. Operating costs, excluding return on investment, vary between 45.0-60.0¢/bbl.

Fluid Hydroforming

Licensed by Esso Research and Engineering Co., New York 19, N. Y., and M. W. Kellogg Co., New York 7, N. Y. Employs the side-by-side arrangement of reactor and regenerator. This process is essentially the Model I type. A Model II type process, which employs inert pellets along with the fluid catalyst to improve heat transfer, has been announced but has not been built commercially as yet.

The first commercial fluid hydroforming unit was placed on stream at the Destrehan, La., refinery of Pan Am Southern Corp. in June 1953.

Fluid Hydroforming references include:

(1) Draeger, A. A., G. T. Given, C. J. G. Leesemann, and M. R. Morrow, "Production of High-Octane Gasoline Component," *Pet. Ref.*, Aug. 1951, pp. 71-6
(2) Murphree, E. V., "Fluid Hydroforming," Advances in Chemistry Series—No. 5, 1951, pp. 58-9
(3) Murphree, E. V., "Fundamentals of Fluid Hydroforming," *Pet. Ref.*, Dec. 1951, pp. 97-101
(4) Petroleum Processing, "Fluid Hydroforming," Aug. 1955, pp. 1190-91
(5) Petroleum Processing, "Moving Bed Catalytic Reforming," June, 1951, pp. 601-2
(6) *Pet. Ref.*, "Fluid Hydroforming," Sept. 1956, pp. 224
(7) Shepardson, R. M., C. W. Tyson, and A. Voorhies, Jr., "Fluid Hydroforming Pilot-Plant; Results of 50 Barrel per Daily Operation," *Oil & Gas J.*, May 19, 1952, pp. 110, 136-41
(8) Tyson, C. W., E. W. Nicholson, and E. J. Gornowski, "Model II Fluid Hydroformer Uses Shot-Catalyst Principle," *Oil & Gas J.*, May 17, 1954, pp. 122-5
(9) Winslow, R. G., and F. C. Hanker, "Esso Fluid Hydroformer Performs," *Pet. Ref.*, Nov. 1955, pp. 214-6

Available engineering services for Esso Fluid Hydroforming:
PROC DESIGN: *6*, 8, *13*, *17*, *22*, 23, *25*, *38*, *40*, *48*, *49*, *52*, *58*, *62*, *70*
MECH ENGRG: *6*, 7, 8, *13*, *17*, *22*, 23, *25*, *38*, *39*, *40*, *48*, *49*, *52*, *58*, *59*, *62*, *70*
CONSTR: *6*, 8, *17*, *22*, 23, *25*, 28, *38*, *39*, *40*, *48*, *49*, *52*, *58*, *59*, *62*, *70*, *79*

In-Line Fluid Hydroforming

Licensed by M. W. Kellogg Co., New York 7, N. Y. Process is primarily a modification of the basic fluid Hydroforming process jointly licensed by Esso Research and Engineering Co. and M. W. Kellogg Co. This process employs the "in-line" stacked single vessel design. The first commercial unit went onstream in April 1955 at the Standard Oil Co. (Ind.), Whiting, Ind., refinery. It was destroyed by an explosion in Aug. 1955. This process was at times referred to as "orthoforming."

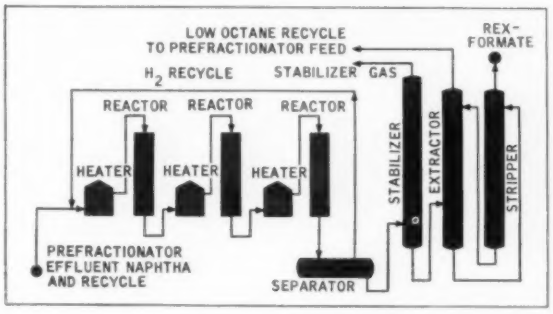
In-Line Fluid Hydroforming references include:

(1) Christopher, R. G., "Orthoforming Unit Produced 100 Clear," *Pet. Ref.*, Sept. 1955, pp. 164-5
(2) Ferrell, R. D., J. R. Tusson and H. A. Parker, "Destrehan Fluid Hydroformer Today," *Pet. Ref.*, Apr. 1955, pp. 121-4
(3) Harang, R. A., "Fluid Hydroforming Units," Pet. Ref., Oct. 1953, pp. 135-8
(4) McGrath, H. G., "The Application of Fluid Hydroforming," *Pet. Ref.*, Dec. 1951, pp. 102-08
(5) Petroleum Processing, "Economics in Catalytic Reforming," Oct. 1951, pp. 1056
(6) Petroleum Processing, "Orthoforming," Aug. 1955, pp. 1188-89
(7) *Pet. Ref.*, "Fluid Hydroforming," Sept. 1956, pp. 210-11
(8) Siebold, J. E., J. W. Bertetti, J. F. Snuggs, and J. A. Bock, "Fluid Hydroforming; Full Scale Unit; First to Use the Fluidized Catalyst Technique," *Oil & Gas J.*, May 19, 1952, pp. 111, 135-6
(9) Swift, J. J., S. R. Stiles, E. W. Howard, and M. Tarnpoll, "New Hydroforming Unit Produces Petrochemicals and AvGas," *Pet. Ref.*, Feb. 1953, pp. 105-9

Available engineering services for Kellogg Fluid Hydroforming:
PROC DESIGN: *58*
MECH ENGRG: *7*, *8*, *39*, *52*, *58*, *59*
CONSTR: *8*, 28, *39*, *52*, *58*, *59*

Reforming with Recycle

Rexforming



A combination process using Platforming and aromatic extraction processes, wherein low octane raffinate is recycled to the Platformer.

A 200-400°F virgin naphtha charge can yield typically (80.0 vol %, approx.) a 98-100 research octane reformate. Operating conditions in the reforming section, because of recycle, can be as much as 50°F lower than conventional Platforming, and higher space velocities are used. A balance is struck between hydrocyclization and hydrocracking, thus avoiding excessive coke and gas formation. Total operating costs, excluding return on investment, are 60-90 ¢/bbl.

The glycol solvent in the aromatics extraction section is similar to that used in the Udex process. It is designed, however, to be less selective and extracts low boiling high octane paraffins as well as aromatics.

The process is licensed by the Universal Oil Products Co., Des Plaines, Ill. The first commercial unit came onstream in April 1956 at the Aurora Gasoline Co.'s Detroit, Mich., refinery.

Rexforming references include:

(1) Grote, H. W., V. Haensel, and M. J. Sterba, "Rexforming," Western Petroleum Refiners Assn., San Antonio, Texas, Mar. 1955—reviewed in Petroleum Processing, Apr. 1955, pp. 495-8
(2) Grote, H. W., V. Haensel and M. J. Sterba, "Rexforming for Octanes Over 100," *Pet. Ref.*, Apr. 1955, pp. 116-20
(3) Grote, H. W., V. Haensel, and M. J. Sterba, "Rexforming—Its Product Will Meet Any Motor-Fuel Needs Now In Sight," *Oil & Gas J.*, Apr. 4, 1955, pp. 233-6
(4) Hunter, W. K., "Rexforming Looks to First Unit," *Pet. Ref.*, Sept. 1955, pp. 145-7
(5) Petroleum Processing, "Cosden's New Rexformer," Nov. 1956, pp. 79-81
(6) Petroleum Processing, "Rexforming," Aug. 1955, p. 1180

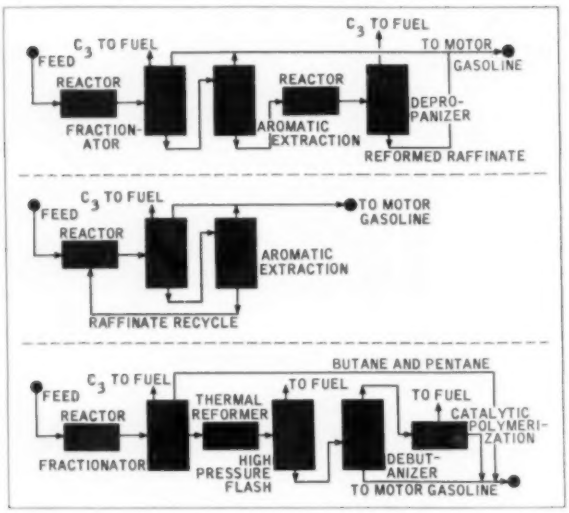
Available engineering services for Rexforming:
PROC DESIGN: *3*, *6*, 8, *22*, *23*, *25*, *29*, *36*, *38*, *40*, *48*, *49*, 56, *58*, 62, 72, 78
MECH ENGRG: *3*, *6*, 7, 8, *14*, *17*, *22*, *23*, *25*, *36*, *38*, *39*, *40*, *48*, *49*, *52*, *56*, *58*, 59, 62, *66*, *70*, 72, *73*, 78
CONSTR: *3*, *6*, 8, *14*, *17*, *22*, *23*, *25*, 28, *29*, *32*, *36*, *38*, *39*, *40*, *48*, *49*, *52*, *56*, *58*, 59, 62, *66*, *70*, 72, *73*, 78, *79*

Iso-Plus Houdriforming

A combination process using a conventional Houdriformer, operated at moderate severity, in conjunction with one of three possible alternatives (including the use of an aromatic recovery unit or a thermal reformer). The raffinate from the aromatic extraction unit is either reformed separately or recycled. The total Houdriformate may be thermally reformed without the use of the aromatic extraction process. Catalytic polymeriza-

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.



Iso-Plus Houdriforming flow schemes

tion of the C_3 and C_4 olefins from thermal reforming is also used in this latter alternate.

Typical feed stock to this type unit consists of the conventional naphtha reforming charge. The use of a Houdry "guard case" permits charging stocks of relatively high sulfur content. Operating conditions are as described for the moderate fixed-bed reforming and aromatic extraction operations. Reformate yields of about 80.0% can result in antiknock quality of 100 plus Research Octane, clear.

Investment costs of $450-550/bbl of daily charge capacity are typical for this process, with operating costs (excluding investment return) of 70-90 ¢/bbl.

No U.S. units are currently onstream, although a unit in Ravenna, Italy—Societa Azionaria Reffinazione Olii Minerali—was started in June 1956.

The Houdry Process Corp., Philadelphia, Penn., is licensor for Iso-Plus.

Iso-Plus references include:

(1) Heinemann, H., "Achieving 100 Octane Clear With Houdry Reforming Processes," *Oil in Canada*, Aug. 1956, pp. 110-22
(2) Heinemann, H., J. B. Maerker, F. R. Walser, and F. W. Kirsch, "High Octanes from 'Iso-Plus' via the Thermal Reforming Route," PETROLEUM PROCESSING, Oct. 1955, pp. 1570-77
(3) Noll, H. D., "Iso-Plus Offers Three Routes to Higher Octane Gasoline," *Pet. Ref.*, Sept. 1955, pp. 135-7
(4) Noll, H. D., J. W. Schall, R. G. Craig, and D. H. Stevenson, "100 Clear Octane By the New Houdry 'Iso-Plus' Process," *Oil & Gas J.*, Mar. 28, 1955, pp. 102-5
(5) PETROLEUM PROCESSING, "Iso-Plus," Aug. 1955, pp. 1181

Available engineering services for Iso-Plus:
PROC DESIGN: *3, 6, 8, 11, 17, 23, 25, 29,* 33, 34, *36, 38, 40, 48, 49, 52, 56, 58, 62, 66, 70, 72*
MECH ENGRG: *3, 6, 7, 8, 11, 17, 19, 23, 25,* 34, *36, 38, 39, 40, 48, 49, 52, 56, 58, 59, 62, 66, 70, 72, 73*
CONSTR: *3, 6, 8, 11, 17, 19, 23, 25,* 28, *29, 36, 38, 39, 40, 48, 49, 52, 56, 58, 59, 62, 66, 70, 72, 73, 79*

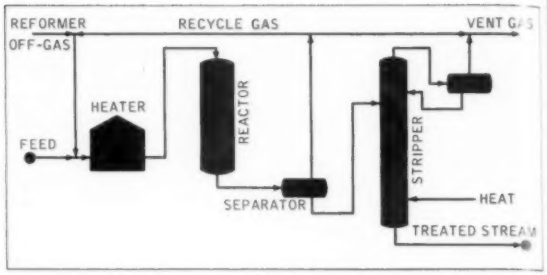
HYDROGEN PROCESSING

Benefits by "purifying" petroleum fractions through hydrogen processing have been known for many years. Because of a lack of cheap hydrogen and the high pressures formerly required, the process did not develop commercially.

The advent of catalytic reforming, and cheap hydrogen-rich off-gas, encouraged hydrogen processing development, and treating pressure requirements were then reduced through advances in catalyst technology.

The functions of hydrogen processing are: removal of sultur and impurities; hydrogen saturation of olefins and/or aromatics; and hydrocracking.

Hydrogen processing is used extensively to prepare reformer



Typical hydrogen processing flow scheme

feedstock and to a lesser extent for catalytic cracking feedstock preparation. Product upgrading of middle distillates, cracked fractions, lube oils, gasolines, and waxes has been increasing rapidly.

The most widely used catalyst is cobalt molybdate on an alumina carrier. Regeneration is accomplished at from 700 to 1200°F with air and steam or flue gas. Catalyst life is 2-5 years. Catalyst poisons consist of carbon, sulfur, nitrogen and polymers.

Feedstock is mixed with recycle and make-up hydrogen (50-90 mol % H_2 reformer off-gas) and heated (400-850°F), then charged to a fixed-bed reactor at 50-1500 psig. Space velocities are 0.5-20 (volume charge per volume catalyst per hour) depending upon process needs. Effluent is cooled, separated from recycle gas, and stripped of H_2S and light ends.

Investment costs for hydrogen treating are $50-$250 bbl, and operating costs are 10¢-20¢/bbl. Costs for hydrocracking are much higher. Early commercial hydrogen processing units were installed by Esso Standard Oil Co. in the 1930s. World War II plants were pioneered by Humble Oil & Refining Co. and Shell Development Co.

Hydrogen treating might outstrip catalytic reforming on a per barrel basis in a few years. Hydrocracking is being seriously considered in specific instances, and some refiners are beginning to look for additional hydrogen.

General literature references include:

(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(2) Kay, Herbert, "What Hydrogen Treating Can Do," *Pet. Ref.*, Sept. 1956, pp. 306-318
(3) Sittig, Marshall and G. H. Unzelman, "Sulfur in Gasoline—An Economic Appraisal," PETROLEUM PROCESSING, Aug. 1956, pp. 75-95
(4) Weber, G., "Spotlight on Hydrogen," *Oil & Gas J.*, May 16, 1955, pp. 126-127

Unifining—Union & UOP

Licensed jointly by either Union Oil Co. of Calif. or Universal Oil Products Co., this is a regenerative, fixed-bed, catalytic process to desulfurize and hydrogenate refinery distillates of any boiling range. Contaminating metals, nitrogen compounds and oxygen compounds are eliminated along with sulfur.

Catalyst is a cobalt-molybdenum-alumina type which may be regenerated in situ with steam and air.

Operating conditions are 500-800°F and 300-800 psig.

The first Unifiners went onstream for United Refining Co. (Union, 750 b/d) at Warren, Pa., and Standard Oil Co. of Ohio (U.O.P. 13,000 b/d) at Lima, Ohio, in 1954.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(2) Eckhouse, J. G., "Unifining Upgrades Distillate Fuels," *Oil & Gas J.*, Aug. 30, 1954, pp. 81-83
(3) Gerald, C. F., "Unifining-Platforming in One Unit," *Pet. Ref.*, May 1956, pp. 216-217
(4) Grote, H. W., et al, "New Data on Unifining," *Pet. Ref.*, Apr. 1954, pp. 165-170
(5) Heinemann, H., "Don't Burn Your Excess Hydrogen," PETROLEUM PROCESSING, July 1953, pp. 1036-1040
(6) Hemmen, G. H., et al, "Unifining—A Proven Refining Technique," 20th Midyear Meeting of the American Petroleum Institute, Div. of Refining, St. Louis, Mo., May 11, 1955
(7) *Oil & Gas J.*, "Unifining," Mar. 21, 1955, pp. 174-175

(9) *Pet. Ref.*, "Unifining," Dec. 1953, p. 85
(9) Poll, H. F., "Unifining—Low Quality Crudes, High Quality Products," 44th Annual Meeting of WPRA San Antonio, Texas, Mar. 1956
(10) Thornton, D. P. Jr., "Electronic Control for New Unifiner," *Oil & Gas J.*, Apr. 9, 1956, pp. 110-112
(11) Watkins, C. H., and A. J. de Rosett, "Hydrogen Use High for Some Stocks," *Pet. Ref.*, Mar. 1957, pp. 201-4
(12) *World Pet.*, New Unifining Process a Treating Aid in Specialty Manufacturing Field," Annual Refinery Review, 1954, pp. 63-65

Available engineering services for Union or UOP Unifining:
PROC DESIGN: 3, 5, 6, 8, *17*, 22, *23*, *25*, *29*, *32*, 38, 40, 47, 48, 49, 52, 56, 58, 62, 72, 77, 78
MECH ENGRG: 3, 6, 8, *11*, *17*, 22, 23, *25*, *38*, *39*, 40, 47, 48, 49, 52, 56, 58, 59, 62, 66, *70*, 72, *73*, 78
CONSTR: *3*, 6, 8, *11*, *17*, 22, 23, *25*, *29*, *32*, *38*, *39*, 40, 47, 48, 49, *52*, 56, 58, 59, 62, 66, *70*, 72, *73*, *79*

Hydrofining—Esso

Licensed by Esso Research & Engineering Co., this is a regenerative, fixed-bed catalytic process to desulfurize, hydrogenate, and improve general quality of a wide range of refinery streams from gases through waxes.

Catalyst is a combination of cobalt and molybdenum oxides on an extruded alumina support and may be regenerated in situ with air and steam or flue gas at 650-750°F. Regeneration requires 1-4 days. Catalyst life may exceed 2 years, depending upon service.

Operating conditions are 400-800°F and 50-800 psig. External hydrogen concentration is kept above 50% and gas is free of carbon monoxide to maintain catalyst activity.

The first Esso Hydrofiner (2500 b/sd) was placed in operation at Esso Standard Oil Co.'s Bayonne, N. J., refinery in 1950 to treat wax.

Literature references include:

(1) Baeder, D. L., and C. W. Siegmund, "Hydrofining is a Natural for Naphthas," *Oil & Gas J.*, Feb. 21, 1955, pp. 122-124, 126
(2) Davidson, R. L., Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138
(3) Jones, W. A., "Hydrofining Improves Low-Cost-Lube Quality," *Oil & Gas J.*, Nov. 1, 1954, pp. 81-84
(4) Lewis, E. H., "Hydrofining Catalytic Cracking Feed Stocks," *Oil & Gas J.*, Apr. 18, 1955, pp. 95-96
(5) Morbeck, R. C., "Hydrofining of Middle Distillates," *Oil & Gas J.*, Jan. 3, 1955, pp. 94-98
(6) *Oil & Gas J.*, "Hydrofining," Mar. 21, 1955, pp. 172-173
(7) Winslow, W. H., and J. Weikart "Processing of Heavy High Sulfur Crude Oil in a Low-Sulfur Refinery," 20th Midyear Meeting of the American Petroleum Institute, Div. of Refining, St. Louis, Mo., May 11, 1955
(8) Zimmerschied, W. J., "Improving Distillate Fuels by Hydrofining," 20th Midyear Meeting of the American Petroleum Institute, Div. of Refining, St. Louis, Mo., May 11, 1955

Available engineering services for Esso Hydrofining:
PROC DESIGN: 3, 8, *13*, *17*, 22, 23, *25*, 38, *40*, *47*, *48*, 49, *52*, *56*, *58*, *60*, *62*, *66*, *70*
MECH ENGRG: 3, 8, *13*, *17*, 22, 23, *25*, *38*, *39*, *40*, *47*, *48*, 49, *52*, *56*, 58, *62*, *66*, *70*
CONSTR: 3, 8, *13*, *17*, 22, 23, *25*, *38*, *39*, *40*, *47*, *48*, 49, *52*, *56*, 58, *62*, *66*, *70*, *79*

Hydrodesulfurization—Indiana

Licensed by Standard Oil Co. of Indiana, this is a regenerative, fixed-bed, catalytic process to desulfurize and hydrogenate refinery stocks from naphthas through lube stocks.

Catalyst is cobalt-molybdenum on alumina to Standard Oil Co. (Ind.) specifications, and may be regenerated in situ using an air-steam mixture. Regeneration uses 10-20 hrs. and may be repeated 50-100 times for a given batch of catalyst. Catalyst life is 2-5 years, depending on feedstock.

Operating conditions are 600-800°F and 200-1500 psig. The process uses reformer off-gas containing 70 mol % hydrogen at a rate of 500-4000 SCF/bbl. Lower concentrations can be used for mild processing.

The process was first installed at the Pine Bend refinery of the Great Northern Oil Co. at St. Paul, Minn.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138
(2) Weber, G., "Spotlight on Hydrogen," *Oil & Gas J.*, May 16, 1955, pp. 126-127
(3) Zimmerschied, W. J., et al, "Improving Distillates by Hydrofining," *Pet. Ref.*, May 1955, pp. 153-155

Available engineering services for Indiana Hydrodesulfurization:
PROC DESIGN: *6*, *8*, *17*, 22, 23, *25*, 38, *40*, *48*, 49, *52*, *56*, 58, 60, *62*, *66*
MECH ENGRG: *6*, *8*, *17*, 22 23, *25*, 38, *39*, *40*, *48*, 49, *52*, *56*, 58, *59*, *62*, *66*
CONSTR: *6*, *8*, *17*, 22, 23, *25*, 38, *39*, *40*, *48*, 49, *52*, *56*, 58, *59*, *62*, *66*, *79*

Vapor-Phase Hydrodesulfurization

Licensed by Shell Development Co., this is a regenerative, fixed-bed, catalytic process that desulfurizes and hydrogenates refinery naphthas boiling up to about 500°F. Olefins may be saturated without hydrogenating aromatics.

Catalyst is tungsten-nickel-sulfide ($5.00/lb) and may be regenerated with air and steam followed by sulfiding with hydrogen sulfide to completely restore activity. Experience indicates an ultimate catalyst life of 600 bbl of cracked naphtha per pound of catalyst.

Operating conditions are 450-700°F and 500-750 psig, with a gas rate of 6000 SCF hydrogen/bbl.

The Vapor-Phase Hydrodesulfurization process (11,150 b/d) was first installed at the Shell Oil Company refinery at Dominguez, Calif., and went onstream March 1944.

Literature references include:

(1) Abbott, M. D., et al, "Vapor-Phase Hydrodesulfurization," *Pet. Ref.*, June 1955, pp. 118-122
(2) Abbott M. D., et al, "Vapor-Phase Hydrodesulfurization Applied to Cracked Naphthas and Light Straight-Run Intermediates," 20th Midyear Meeting of American Petroleum Institute, Div. of Refining, St. Louis, Mo., May 11, 1955
(3) Casagrande, R. M., et al, "Selective Hydrotreating over Tungsten Nickel Sulfide Catalyst," *Ind. & Engrg. Chem.*, Apr. 1955, pp. 744-749
(4) Cole, R. M., and D. D. Davidson, "Hydrodesulfurization of Gasoline Fractions with Tungsten-Nickel Sulfide Catalyst," *Ind. & Engrg. Chem.*, Dec. 1949, pp. 2711-2715
(5) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956 pp. 115-138
(6) Meerbott W. K., and G. P. Hinds, Jr., "Selective Hydrotreating over Tungsten Nickel Sulfide Catalyst—Pure Compounds," *Ind. & Engrg. Chem.*, Apr. 1955 pp. 749-752
(7) *Oil & Gas J.*, "Catalytic Hydrogenation of Octenes to Octanes," May 26, 1938, p. 50

Available engineering services for Shell Vapor-Phase Hydrodesulfurization:
PROC DESIGN: *8*, *17*, *23*, *25*, *47*, *52*, *56*, *58*, *62*, 64
MECH ENGRG: *8*, *17*, *23*, *25*, *39*, *47*, *52*, *56*, *58*, 59, *62*
CONSTR: *8*, *17*, *23*, *25*, *39*, *47*, *52*, *56*, *58*, 59, *62*, *79*

Trickle Hydrodesulfurization

Licensed by Shell Development Co., this is a regenerative, fixed-bed, catalytic desulfurization process that eliminates 85-90% sulfur from middle distillates, gas oil, etc.

Catalyst is pelleted cobalt-molybdenum on alumina ($1.00-$1.50/lb) and may be regenerated to original activity in situ with a mixture of steam and air at about 1100°F. Several regenerations are possible; ultimate life of the catalyst depends upon material processed.

Operating conditions are 680-730°F and 750-850 psig when processing middle distillates for 80% or higher sulfur removal. Recycle gas requirements are 250-1000 SCF/bbl of charge and space velocity 2-6 v/hr/v.

Shell Refining and Marketing Co. Ltd. of Stanlow, England put the first Trickle Hydrodesulfurization unit (7000 b/sd) onstream in April 1955.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956 pp. 115-138
(2) Hoog, H., et al, "Shell Hydrodesulfurization Process," 18th Midyear Meeting of the American Petroleum Institute's Div. of Refining, New York, N. Y., May 13, 1953

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

(3) Hoog, H., et al, "Desulphurization of Gas Oils by Hydrogenation and by Extraction," *Proc. Third World Petroleum Congress*, The Hague, Section IV, 1951
(4) Klinkert, H. G., and H. M. Penning, "Shell 'Trickle' Hydrodesulurizer," *Pet. Ref.*, Sept. 1955, pp. 150-154

Available engineering services for Shell Trickle Hydrodesulfurization:
PROC DESIGN: *8, 17, 23, 25,* 38, 47, *49, 52, 56, 58, 62,* 64
MECH ENGRG: *8, 17, 23, 25, 38, 39,* 47, *49, 52, 56, 58, 59, 62*
CONSTR: *8, 17, 23, 25, 38, 39,* 47, *49, 52, 56, 58, 59, 62, 79*

Sinclair Hydrogen Treating

Using a catalyst developed by Sinclair Research Laboratories, Inc., and manufactured by National Aluminate Corp., this is a regenerative, fixed-bed, catalytic process to remove sulfur, nitrogen, oxygen and metal contaminants from a wide range of refinery streams.

Catalyst type (RD-154) is extruded cobalt-molybdenum on alumina. Regeneration to original activity takes 24-72 hours with an air-steam mixture. Numerous regenerations appear possible with potential yields of 100-250 bbl/lb.

Operating conditions are 580-750°F and 200-800 psig with hydrogen recycle rates of 500-5000 SCF/bbl feed. Reformer off-gas with at least 65 mol % hydrogen is used.

The first unit (10,000 b/d cycle oil) was placed on stream Dec. 30, 1955 for the Sinclair Refining Co., Marcus Hook, Pa., refinery. RD-154 may be purchased and arrangements for its use made through National Aluminate Corp.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138

Available enngineering services for Sinclair Hydrogen Treating:
PROC DESIGN: 8, *13, 17, 23, 25,* 49, 52, *56, 58,* 62
MECH ENGRG: 8, *13, 17, 23, 25, 39,* 49, *52, 56, 58, 59, 62*
CONSTR: 8, *13, 17, 23, 25, 39,* 49, *52, 56, 58, 59, 62, 79*

Diesulforming

Licensed by Husky Oil Co., Diesulforming is a regenerative, fixed-bed, catalytic process to desulfurize and upgrade refinery naphtha, middle distillate, and gas oil streams.

Catalyst ($1.00/lb) is pelleted molybdenum and may be regenerated in situ with an air-steam mixture. Activity is restored in 2-3 days.

Operating conditions are 650-800°F and 450-550 psig. Minimum hydrogen recycle rate is 5000 SCF/bbl feedstock. Hydrogen concentration in the gas stream, when lowered, reduces desulfurization activity but is still effective at 50 mol %.

The Diesulforming process was first placed in operation Aug. 12, 1953 at the Husky Oil Co.'s Cody, Wyo. refinery.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(2) Odasz, F. B., and J. V. Sheffield, "Diesulforming . . . Husky Oil Company's Desulfurization Process," *Oil & Gas J.*, March 21, 1955, pp. 203-204

Available engineering services for Diesulforming:
PROC DESIGN: *17, 23,* 29, *37, 52, 56, 58, 62*
MECH ENGRG: *17, 23, 39, 52, 56, 58, 59, 62*
CONSTR: *17, 23,* 29, *39, 52, 56, 58, 59, 62, 79*

Hydropretreating—Houdry

Licensed by Houdry Process Corp. (usually in conjunction with Houdriformers), this process is also called the "Houdry Guard Case." It is a non-regenerative, fixed-bed (Guard Case) catalytic process to desulfurize and hydrogenate catalytic reformer charge stock.

Catalyst is either Houdriforming type 3 catalyst (containing platinum) or cobalt-molybdenum on alumina made by Houdry Process Corp.

Operating conditions are 700-755°F and around 400 psig with a high space velocity of 10-20 vol charge/vol catalyst/hr. Hydrogen produced in Houdriforming (600-1000 cu ft/bbl) is ample to satisfy Hydropretreating of any Houdriformer feed. Investment and operating costs are generally included with Houdriforming.

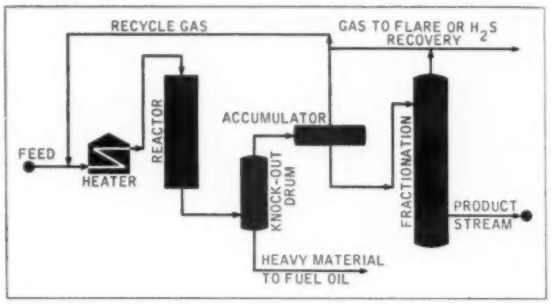
Two Hydropretreating units are operating to purify Houdriformer feed stock; 5000 b/d at the Crown Central Petroleum Corp. of Houston, Texas; and 13,000 b/d at the Ohio Oil Co., Robinson, Ill. refinery.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(2) Steveson, D. H., and G. A. Mills, "Hydropretreatment of Catalytic Reformer Feed," *Pet. Ref.*, August 1955, pp. 117-210
(3) *World Pet.*, "New Guard Case Houdriformer at Crown Central Refinery," Feb. 1955, pp. 44-46

Available engineering services for Houdry Hydropretreating:
PROC DESIGN: *8,* 11, *17, 23, 25,* 32, 33, 34, 38, *40,* 47, *48, 49, 56, 58, 62, 72*
MECH ENGRG: *8,* 11, *17, 23, 25,* 34, 38, *39, 40,* 46, 47, *48, 49, 52, 56, 58, 62, 72, 73*
CONSTR: *8* 11, *17, 23, 25,* 28, 32, 33, 34, 38, *39, 40,* 46, *47, 48, 49, 52, 56, 58, 62, 72, 73, 79*

Autofining



Licensed by The British Petroleum Co. Ltd., Autofining is a fixed-bed catalytic desulfurization process for a wide range of high sulfur stocks from gasolines through gas oils.

Catalyst is pelleted cobalt-molybdate oxides on alumina, and may be regenerated in situ at 800° F with steam-air or inert gas-air mixtures. The length of a catalyst run varies with the feed material, from 200 to 1000 hrs. Ultimate life has been reported as over four years in some instances.

Operating temperatures (700-800° F) and pressures (50-200 psig) are controlled to give enough hydrogen by dehydrogenation of feedstock naphthenes for conversion of sulfur in the feedstock into H_2S. No outside hydrogen is needed. Excess hydrogen in the process gas (80% H_2) is recycled to the desulfurization zone.

The first commercial autofining plant was installed at the Llandarcy refinery of National Oil Refineries Ltd., Wales, in July 1952.

Literature references include:

(1) Hyde, H. W., and F. W. B. Porter, "The Autofining Process: The Production of Low Sulfur Diesel Oils," *Proceedings Fourth World Congress* Section III/C
(2) Jones, C. M., "Desulfurizing Process Has Wide Applications," *Pet Engr.*, July 1953, pp. C27-28
(3) Lomax, E. L., "Autofining Desulfurization Process," *World Pet.*, June 1952, pp. 62-63
(4) *Pet. Engr.*, "The Autofining Process," July 1952, pp. C31-32
(5) PETROLEUM PROCESSING, "New Autofining Process," Apr. 1952, pp. 467-469
(6) PETROLEUM PROCESSING, "Three New Refining Processes," May 1953, pp. 683-686

Available engineering services for Autofining:
PROC DESIGN: *8, 17, 22, 23, 46, 48, 52, 56, 58, 70*
MECH ENGRG: *8, 17, 22, 23, 39, 46, 48, 52, 56, 58, 59, 70*
CONSTR: *8, 17, 22, 23, 39, 46, 48, 52, 56, 58, 59, 70, 79*

Hydrofining—BP

Developed by The British Petroleum Co. Ltd., this is a regenerative, fixed-bed hydrogen process designed to desulfurize virgin gas oil or blends of virgin gas oil and cracker cycle oil with little or no molecular break-down.

Catalyst is pelleted cobalt-molybdenum oxide on alumina type and may be regenerated in 24 hours by a steam-air mixture at temperatures of 800-1100° F.

Operating conditions are 760-790° F and 500-1000 psig with

normal hydrogen recycle rate of 400 SCF/bbl.

The process was placed in operation at Kwinana, W. A. for the Australasian Petroleum Refinery Ltd. to produce low sulfur diesel fuels (5600 b/d), and is said to be the first operation of its kind. M. W. Kellogg Co. constructed the unit using process data from British Petroleum Co. Ltd.

Literature references include:

(1) Sutherland, D. A., and F. W. Wheatley, "Desulfurizing by Hydrofining 'Down Under'," *Pet. Engr.*, Mar. 1956, pp. C37, 40, 42, 44

Available engineering services for BP Hydrofining:
PROC DESIGN: *8, 17, 23, 48, 52, 56, 58, 70*
MECH ENGRG: *8, 17, 23, 39, 48, 52, 56, 58, 70*
CONSTR: *8, 17, 23,* 28, *39, 48, 52, 56, 58,* 70, *79*

Diolefin Hydrogenation

Licensed by Shell Development Co., this is a regenerable, fixed-bed, catalytic process to hydrogenate diolefins to monoolefins in alkylation feed stock with negligible olefin saturation. Stocks processed are C_4 and C_5 fractions.

Catalyst is pelleted nickel sulfide on alumina ($1.00-1.50/lb) and may be regenerated in situ at 750° F with a mixture of air and steam followed by sulfiding with hydrogen sulfide to completely restore activity.

Operating conditions are 480-660° F at 15-150 psig using 1:1 mol ratio of hydrogen to feed, and space velocity of 2-8 v/hr/v. Reformer off-gas may be used as the hydrogen source.

Treatment reduces alkylation acid consumption and increases the value of the feedstock by converting butadiene to butylene.

The first unit (400 b/d) was placed in operation for the Shell Refining & Marketing Co. Ltd. at Stanlow, England, in 1949.

Literature references include:

(1) Anderson, J. S. H., et al, "Diolefins in Alkylation Feed Stocks," *Ind. & Engrg. Chem.*, Dec. 1948, pp. 2295-2301
(2) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Available engineering services for Shell Diolefin Hydrogenation:
PROC DESIGN: *8, 17,* 23, *49, 52, 58, 62, 70*
MECH ENGRG: *8, 17,* 23, *39, 49, 52, 58, 62, 70*
CONSTR: *8, 17,* 23, 28, *39, 49, 52, 58, 62, 70, 79*

Feed Preparation—Phillips

Licensed by Phillips Petroleum Co., one unit for this hydrogen treating process (10,000 b/d) is installed by Phillips at its Phillips, Texas, refinery for desulfurization, olefin saturation, and color stability of naphthas and kerosine.

Catalyst used is molybdenum type.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Available engineering services for Phillips Feed Preparation:
PROC DESIGN: *8, 17, 23, 25, 29,* 49, *52, 54,* 56, *58, 62*
MECH ENGRG: *8, 17, 23, 25, 39,* 49, *52, 56, 58,* 59, *62, 73*
CONSTR: *8, 17, 23, 25, 29, 39,* 49, *52, 56, 58,* 59, *62, 73, 79*

Hydrodesulfurization—Sun

Developed and licensed by Sun Oil Co., one unit of this hydrogen treating process (1500 b/d) is in operation by Sun Oil Co. at the Marcus Hook, Penn., refinery for lube oil finishing.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Available engineering services for Sun Hydrodesulfurization:
PROC DESIGN: *8, 11, 17, 23, 52, 56, 58, 62, 72*
MECH ENGRG: *8, 11, 17, 23, 39, 52, 56, 58, 59, 62, 72*
CONSTR: *8, 11, 17, 23, 39, 52, 56, 58, 59, 62, 72, 79*

Platreating

Licensed by Universal Oil Products Co., this is a hydrogenation process to refine aromatic concentrates so that pure benzene and toluene may be recovered. The process is operated in conjunction with Platforming and Udex and may utilize excess hydrogen from either unit.

The first Platreater was installed for the Roosevelt Oil & Refining Corp. at Mt. Pleasant, Mich., in January, 1953.

Literature references include:

(1) Daudler, J. E., "New Processes Expand Market for Roosevelt Oil," Petroleum Processing, July, 1953, pp. 990-991

Available engineering services for Platreating:
PROC DESIGN: *3, 8, 17, 23, 25, 32,* 40, *48, 52, 56, 58, 62,* 72, *78*
MECH ENGRG: *3, 8, 17, 23, 25, 39,* 40, *48, 52, 56, 58,* 59, *62,* 66, *72, 73, 78*
CONSTR: *3, 8, 17, 23, 25, 32, 39,* 40, *48, 52, 56, 58,* 59, *62,* 66, *72, 73, 79*

Hydrodesulfurization—Kellogg

Furnished by M. W. Kellogg Co, this is a hydrogen treating process primarily used to desulfurize and purify catalytic reformer feedstock. The catalyst is cobalt molybdate on alumina.

One unit (3000 b/d) is onstream at Pure Oil Co.'s Newark, Ill., refinery to treat reformer feedstock. An 18,000 b/d unit is planned for Pure at Lemont, Ill., to desulfurize straightrun gasoline.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Available engineering services for Kellogg Hydrodesulfurization:
PROC DESIGN: *17, 52, 58*
MECH ENGRG: *17, 39, 52, 58, 59*
CONSTR: *17, 39, 52, 58, 59, 79*

Hydrobon

Hydrobon was the name given to the Universal Oil Products Co.'s hydrogen process before a patent arrangement was made with Union Oil Co. of Calif. to license the process jointly under the name Unifining.

The only plant (13,000 b/d) licensed by U.O.P. under the name Hydrobon was for Standard Oil Co. of Ohio at the Lima, Ohio refinery. Onstream date for this unit was 1954.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Cobalt Molybdate Desulfurization

A process developed by the Union Oil Co. of Calif. which became part of a patent arrangement with Universal Oil Products Co. to jointly license Unifining. The catalyst used by Union for Unifining differs in that it contains silica (Harshaw Chemical Co.).

The first hydrogen process under Union license was 750 b/d for the United Refining Co., Warren, Pa., and began operating in 1954.

Literature references include:

(1) Berg, Clyde, "Catalytic Desulfurization of High Sulfur Stocks by the Cobalt Molybdate Process," *Chem. Engrg. Prog.* Jan. 1947, pp. 1-12
(2) Berg, Clyde, "Union's Cobalt Molybdate Process for Refining High Sulfur Stocks," Petroleum Processing, Feb. 1952, pp. 186-189
(3) Byrns, A. C., et al, "Catalytic Desulfurization of Gasolines by Cobalt Molybdate Processes," *Ind. & Engrg. Chem.*, Nov. 1943, pp. 1160-1167
(4) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Sovafining

This is a private hydrogen treating process installed by Socony Mobil Oil Co., Inc. at its own refineries to the extent of over 90,000 b/d capacity. Operation includes pretreatment of straightrun and thermal naphtha for Sovaformer feed and

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Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

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desulfurization, stabilization of sour No. 2 fuel oil components.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Hydrotreating—Texaco

Developed by The Texas Co., this process is installed at two company refineries (10,000 and 6500 b/d) for desulfurization of catalytically cracked distillate and heavy cracked gasoline.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138

Available engineering services for Texaco Hydrotreating:
PROC DESIGN: *8, 17, 23, 25, 40, 49, 56, 58, 62*
MECH ENGRG: *8, 17, 19, 23, 25, 39, 40, 49, 52, 56, 58, 59, 62*
CONSTR: *8, 17, 19, 23, 25, 28, 39, 40, 49, 52, 56, 58, 59, 62, 79*

Gulfining

This is a private hydrogen treating process developed by Gulf Research & Development Co. to upgrade cracked and straight run distillates and fuel oils by reducing sulfur content, improving carbon residue, color, and general stability along with slightly increasing the API gravity.

The process involves reacting hydrogen at 600-800° F with fuel oil distillate streams in the presence of an unidentified catalyst at 600 psig.

Two units with a combined capacity of 45,000 b/d were built at the Gulf Oil Co.'s Port Arthur, Texas, refinery, and went onstream Jan. 1957. Two more with a combined capacity of 45,000 b/d went onstream at Philadelphia this spring.

Literature references include:

(1) Gilmartin, R. P. "Hydrogen Treatment Improves Fuel Oils," *Oil & Gas J.*, Feb. 6, 1956, pp. 85-88

Gulf HDS

Developed by Gulf Research & Development Co., with primary licensing through M. W. Kellogg Co., the Gulf HDS process is regenerative fixed-bed, catalytic hyrdocracking of heavy residuals to lower boiling distillates with accompanying desulfurization. Whole crudes, virgin and cracked residuals serve as feed stock.

Catalyst ($1.00-$1.50 lb) is a metallic compound supported on pelleted alumina which may be regenerated in situ with air and steam or flue gas through a temperature cycle (750 to 1200 F). Catalyst life is estimated at 2 years.

Operating conditions are 750-850° F and 500-1000 psig, with 2500-5000 SCF/bbl recycle gas (having 65-90 mol% H_2) needed.

A 50 b/d pilot plant was operated for five years at the Gulf Oil Corp.'s Port Arthur, Texas, refinery.

Literature references include:

(1) Davidson, R. L., "Hydrogen Processing," Petroleum Processing, Nov. 1956, pp. 115-138
(2) McAfee, J., et al, "The Gulf HDS Process for Upgrading Crudes and Residues," 20th Midyear Meeting of the American Petroleum Institute, Div. of Refining, St. Louis, Mo., May 11, 1955

Available engineering services for Gulf HDS:
PROC DESIGN: *8, 17, 52, 56, 58, 62*
MECH ENGRG: *8, 17, 39, 52, 56, 58, 59, 62*
CONSTR: *8, 17, 39, 52, 56, 58, 59, 62, 79*

Hydrocracking—Houdry

Developed and licensed by Houdry Process Corp., this is a continuous fixed-bed, catalytic process to upgrade residua to lighter products, and at the same time effect desulfurization.

Catalysts applicable include NiO or NiS on silica alumina and commercial type cobalt-molybdena on alumina (the latter being most active). Catalyst can be used for long periods without regeneration.

The residua feed is diluted with a light hydrocarbon (35% butane in feed). This allows operation to 3500 psig and over 800° F with no significant coke build-up on catalyst. Hydrogen consumption varies with the charge but is in the range of 2000 SCF/bbl.

Gasoline recovered from hydrocracking has a low octane and must be reformed. Gas oil is of excellent quality and may be compared to virgin stock.

Literature references include:

(1) Heinemann, H., and D. H. Steveson "Hydrocracking of Residua," Div. of Petroleum Chemistry, American Chemical Society, Atlantic City, N. J., Sept. 17-21, 1956

Available engineering services for Houdry Hydrocracking:
PROC DESIGN: *3, 8, 11, 17, 23, 25, 34, 36, 40, 47, 48, 49, 52, 56, 58, 62, 72*
MECH ENGRG: *3, 8, 11, 17, 19, 23, 25, 34, 36, 39, 40, 47, 48, 49, 52, 56, 58, 59, 62, 72, 73*
CONSTR: *3, 8, 11, 17, 19, 23, 25, 28, 32, 36, 39, 40, 47, 48, 49, 52, 56, 58, 59, 62, 72, 73, 79*

Residuum Hydroconversion—Humble

Developed by Humble Oil & Refining Co., this is a hydrocracking process to upgrade residual stocks (asphalt, visbreaker tar, vacuum crude residuum, etc.) to quality products by "hydrodesulfurization and hydroconversion." A license may be obtained from Esso Research & Engrg. Co.

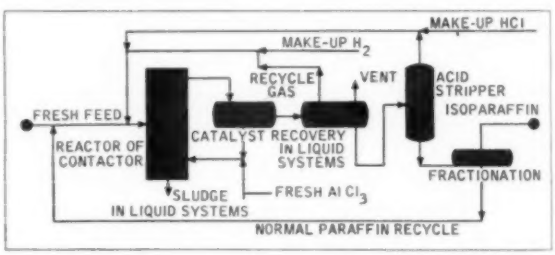
Catalyst is cobalt-molybdate supported on alumina and "runs" of 600-1000 hours are possible. Regeneration may be effected by burning carbon (800-1050°F) with an air-inert gas mixture. Numerous regenerations have been shown possible and ultimate life has been estimated at over a year.

Asphalt hydrogenation is conducted at 725-825°F and 400-800 psig, with feed rates of 0.5-2.0 volumes of liquid feed/hour/volume of catalyst. From 1500 to 4500 SCF hydrogen/bbl feed are needed.

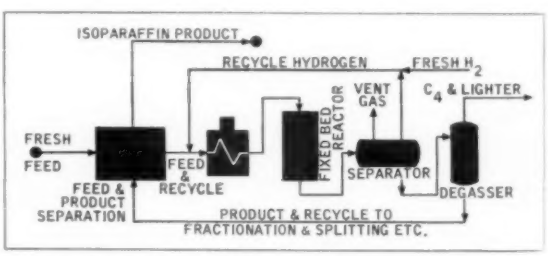
Literature references include:

(1) Gwin, G. T., "Hydrogenation of Asphalt for Fuel Products," Division of Petroleum Chemistry, American Chemical Society, Atlantic City, N. J., Sept. 17-21, 1956

ISOMERIZATION



Typical aluminum chloride isomerization flow diagram



Typical noble metal isomerization flow diagram

Present isomerization applications to refining are to give feedstock for alkylation units or high octane fractions for gasoline blending. Straight-chain paraffins (n-butane, n-pentane, n-hexane) are converted to respective iso-compounds by continous, catalytic (aluminum chloride, noble metals) processes. Natural gasoline, light straight-run gasoline, and LPG can provide feed by fractionating and/or splitting. High volumetric

yields (95%+) and 40-60% conversion per pass are characteristic.

Non-regenerable aluminum chloride catalyst is employed with various carriers in a fixed-bed or liquid contactor. Platinum or other metal catalyst processes utilize fixed-bed operation, and can be regenerable or non-regenerable.

Reaction conditions vary widely depending upon the particular process and feed, 180-900° F and 150-300 psig. Residence time in the reactor is 10-40 minutes.

Investment costs are $100-$300/bbl, and operating costs are 10-20¢ bbl. Fractionation costs are not included.

Isomerization found initial commercial application during World War II for making high octane aviation gasoline components and additional feed for alkylation units. Because of lowered alkylate demands, all but six of an original thirty butane isomerization units (36,650 b/d) were converted or shutdown after hostilities ceased. Demand for motor fuel alkylate is evidenced by new butane isomerization commitments.

Attractive features are products with 93-107 Research Octane at 3 ml TEL/gal. Iso-paraffin road performance is excellent in the present-day high compression automotive engine.

Economic studies of pentane, hexane units are presently widespread in the industry. Five isomerization processes have been developed or improved within the last year to provide motor fuel components.

Literature references include:

(1) Armistead, G. Jr., "Isomerization and Isoforming—Pentane," *Oil & Gas J.*, Oct. 5, 1946, p. 80
(2) Coulthurst, L. J., "Isomerization of Feed Stocks Charged to Alkylation Units," *Oil & Gas J.*, Jan. 23, 1941, p. 37
(3) Finger, J. S., "Fundamentals of Isomerization for Operators," *Pet. Ref.*, Jan. 1946, pp. 105-110
(4) Foster, A. L., "Facts and Possibilities of Alkylation and Isomerization Processes," *Oil & Gas J.*, Apr. 15, 1943, p. 71
(5) Foster, A. L., "Isomerization a Useful but as yet Little Used Tool for the Refiner," *Oil & Gas J.*, Feb. 25, 1943 & Mar. 4, 1943
(6) Frost, A. V., "Improvement of Octane Rating of Gasoline by Isomerization," *Oil & Gas J.*, July 29, 1944, p. 165
(7) Lovell, R. G., "Distillation and Isomerization," *Pet. Engr.*, Sept. 1944, p. 118
(8) O'Donnell, J. P., "Shells Wood River Plant . . . 100 Octane Manufacture," *Oil & Gas J.*, May 4, 1944, pp. 33-34
(9) Parker, F. D. & E. G. Rogatz, "Refinery Processes for War Products," *Pet. Ref.*, Dec. 1943, pp. 105-115
(10) Perry, S. F., "Isomerization for the Past Two Years," *Ind. & Engrg. Chem.*, Sept. 1952, pp. 2037-2039
(11) Perry, S. F., "Isomerization of Light Hydrocarbons," *Pet. Engr.*, July 1947, pp. 185-188
(12) *Pet. Ref.*, "Liquid Phase Isomerization," Feb. 1944, pp. 103-104
(13) Simpson, F. M., "Alkylation & Isomerization Combined in Aviation Gasoline Plant," *Oil & Gas J.*, Jan. 23, 1941, p. 37

Penex

Licensed by Universal Oil Products Co., Penex is a continuous, non-regenerative C_5 and/or C_6 process for isomerization in the presence of hydrogen (from reforming) employing a platinum catalyst. Reactor conditions are so selected that catalyst regeneration is not required.

Upgrading pentane fractions may be accomplished with a product yield of 99.5% and leaded quality increase of 7-8 Research Octane. With hexane fractions, product yield is 97% and leaded quality increase about 9 Research Octane.

Penex may be applied to many feed stocks by varying the fractionating system. Mixed feeds may be split into pentane and hexane fractions and respective iso-fractions separated from each. Normal-fractions would be processed in individual C_5 or C_6 Penex systems. Each stream could then be taken to storage or returned to fractionation for separation of iso-product and recycle. The system can operate in conjunction with reforming of the C_7+ naphtha fraction.

Literature references include:

(1) Grote, H. W., "Isomerize C_5 and C_6 with Penex," *Pet. Ref.*, July 1956, p. 148
(2) *Oil & Gas J.*, "High Octanes at Low Cost," July 23, 1956, p. 96+
(3) Petroleum Processing, "Penex—Platforming of Naphthas," Aug. 1956, pp. 66-67.

Available engineering services for Penex:
PROC DESIGN: ***3, 6, 8, 23, 25, 29, 32, 40, 47, 48, 58, 58, 62, 72***
MECH ENGRG: ***3, 6, 8, 17, 23, 25, 39, 40, 47, 48, 52, 56, 58, 59, 62, 66, 72, 73, 78***
CONSTR: ***3, 6, 8, 17, 23, 25, 28, 29, 32, 36, 39, 40, 47, 48, 52, 56, 58, 59, 62, 66, 72, 73, 78, 79***

Isomerate

Licensed by Pure Oil Co., Isomerate is a continuous isomerization process designed to convert pentanes, hexanes and heptanes. A rugged metal catalyst is used in a fixed-bed reactor system.

Operating conditions are mild, being less than 750 psig and 750° F. Outside hydrogen is added to the feed along with recycle gas. Usual operation would include fractionation facilities to recycle normal-paraffins almost to extinction Example 200° F end point, light deisopentanized gasoline feed stock of 64.4 clear Research Octane upgraded to 97.0 leaded Research Octane. Isomer yields approached 100%.

Literature references include:

(1) *Oil & Gas J.*, "New Process Expands High Octane Pool—Pure Oil Company's Isomerate Process," Apr. 30, 1956

Available engineering services for Isomerate:
PROC DESIGN: ***8, 17, 23,* 33, 49, *52, 56, 58, 62***
MECH ENGRG: ***8, 17, 23, 39, 49, 52, 56, 58, 62, 73***
CONSTR: ***8, 17, 23, 28, 39, 49, 52, 56, 58, 62, 73, 79***

Iso-Kel

Licensed by M. W. Kellogg Co., Iso-Kel is a fixed-bed, vapor-phase isomerization process using a precious metal catalyst and external hydrogen. A wide variety of feed stocks, including natural gasoline, pentane and/or hexane cuts, can be processed. Fractionation design can vary. One approach is to yield separate isopentane and isoheptane product streams for greater blending flexibility.

Example light naphtha charge showed a 97 vol % combined stream yield having a 96 leaded Research Octane. Natural gasoline feed showed 99% yield and 99.8 leaded Research Octane.

Payout time is estimated at 19 months for a 3100 b/d unit incorporated in a 50,000 b/d refinery.

Literature references include:

(1) *Oil & Gas J.*, "Refiners Handed New Up-Grading Tool," Jan. 7, 1957, p. 76+
(2) Petroleum Processing, "The Iso-Kel Isomerization Process," Jan. 1957, p. 135
(3) *Ref. Engr., The*, M. W. Kellog Advertisement, Jan., 1957, p. C4+

Available engineering services for Iso-Kel:
PROC DESIGN: 33, ***58***
MECH ENGRG: ***39, 58***
CONSTR: 28, ***39, 58***

Isomate

Licensed by Standard Oil Co. (Ind.), Isomate is a continuous, non-regenerative C_5 and C_6 or C_6 naphtha process using aluminum chloride hydrocarbon complex catalyst with anhydrous hydrochloric acid as a promotor. Hydrogen partial pressure is maintained to suppress undersirable reactions (cracking and disproportionation) and retain catalyst activity.

Isomerization proceeds at 240-250° F and 700-800 psig reactor conditions. Feed is saturated with anhydrous HCl in a prereactor absorber, then is heated and combined with hydrogen, and charged to the reactor. Catalyst is added to the reactor separately and the reaction takes place in the liquid phase.

Product is caustic and water washed, acid stripped, and stabilized before going to storage in once-through operation. To provide recycle and a higher octane product, high octane isomers are separated in a product splitter. C_6 naphthenes and heavier material are removed from recycle in a rerun tower.

Research octane with 3 ml TEl/gal of 97 can be realized on

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, **3**) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

mixed feed using once-through operation; 95 on hexane, once-through; and 106 on hexane (stabilized and rerun) with recycle. Yields of above octane material are about 96, 96 and 82 vol % respectively. In the latter case, an additional 10-12 vol % of naphthenes is produced.

Two commercial plants operated during World War II for aviation blending stock, and improvements have adapted the process to motor gasoline stock manufacture.

Literature references include:

(1) Evering, B. L. et al, "Commercial Isomerization of Light Paraffins," *Nat. Pet. News*, Nov. 1, 1944, p. R737
(2) Murphy, G. B., "Catalytic Isomerization . . . Supply," *Nat. Pet. News*, Dec. 24, 1941, p. R401-402
(3) *Pet. Ref.*, "Isomate," Sept. 1952, p. 172
(4) Swearington, J. E. et al, "Isomate Process," PETROLEUM PROCESSING, Oct. 1946, p. 140
(5) Swearington, J. E., et al, "The Isomate Process," *Amer. Inst. of Chem. Engrs. Trans.*, 42, 573, Aug. 1946

Available engineering services for Isomate:
PROC DESIGN: *3, 8, 17, 23, 25,* 33, *40, 48,* 52, *56, 58, 62*
MECH ENGRG: *3, 8, 17, 23, 25, 39, 40, 48, 52, 56, 58, 62*
CONSTR: *3, 8, 17,* 23, *25,* 28, *39, 40, 48, 52, 56, 58, 62, 79*

Pentafining

Licensed by Atlantic Refining Co., Pentafining is a regenerable pentane isomerization process using platinum catalyst on silica-alumina support and requiring outside hydrogen. Natural gasoline feed is depentanized and heavy material goes to a low-pressure reformer. Pentane fraction is split and the normal fraction is combined with recycle and make-up hydrogen, heated, and charged to the reactor (300-700 psig and 800-900° F). Effluent has recycle hydrogen removed, is degassed, and taken to fractionation to separate normal- and iso-(95% purity) fractions. Catalyst is regenerated with a 500-1000° F steam-air mixture.

Reforming may be tied in with the system to provide a convenient hydrogen source. With natural gasoline feed (12 lb) to the two processes, a 93-94% yield and 100 leaded octane product is realized.

Literature references include:

(1) PETROLEUM PROCESSING, "Isomerization of Normal Paraffins," Oct. 1956, p. 101+
(2) Worrell, G. R., "Now 100 Octane from Natural Gasoline," *Pet. Ref.*, Apr. 1956, p. 138

Available engineering services for Pentafining:
PROC DESIGN: *3, 6, 8, 17, 22, 23, 25, 29,* 33, *36,* 38, *40, 47, 49, 51, 52, 56, 58, 62*
MECH ENGRG: *3, 6, 17, 22, 23, 25, 36, 38, 39, 40, 47, 49, 51, 52, 56, 58, 62, 73*
CONSTR: *3, 6, 17, 22, 23, 25,* 28, *29, 36, 38, 39, 40, 47, 49, 51, 52, 56, 58, 62, 73, 79*

Butane Vapor-Phase

Licensed by Shell Development Co., this is a continuous, non-regenerative C_4 process using aluminum chloride catalyst on a granular support (alumina) and HCl gas as a catalyst promoter. One or more reactors may be either bed-type or tube heat exchange-type. Guard case protection follows the reactors.

Prepared n-butane feed reacts at 250-290° F and 200-250 psig to yield 35-45 vol % isobutane in product. Vapor-phase reactor effluent is condensed by cooling and refrigeration, and non-condensables are removed. Recycle HCl is removed from mixed liquid butanes, which are then caustic washed before separation of isobutane.

Literature references include:

(1) Chaney, H. A. & C. L. Raymond, "Shell Vapor-Phase Isomerization Process for the Production of Isobutane," *Amer. Inst. Chem. Eng. Trans.*, Aug. 1946, pp. 595-609
(2) Coulthurst, L. J., "Shell Isomerization Process for Producing Isobutane," *Pet. Engr.*, Jan. 1942, p. 116+
(3) *Nat. Pet. News*, "Catalytic Isomerization Process for Producing Isobutane," Dec. 24, 1941, p. R403+
(4) Persyn, C. L., "Shell Vapor-Phase Isomerization," *Oil & Gas J.*, Feb. 11, 1952
(5) U. S. Patents 2105850, 2249366, 2250118 and 2250410

Available engineering services for Shell Butane Vapor-Phase Isomerization:
PROC DESIGN: *8, 17, 22, 23, 25,* 33, *36, 48, 49,* 52, *58, 62,* 64
MECH ENGRG: *8, 17, 22,* 23, *25, 36, 39, 48, 49, 52, 58, 62*
CONSTR: *8, 17,* 22, 23, *25,* 28, *36, 39, 48, 49,* 52, *58, 62, 79*

Aluminum Chloride

As licensed by Universal Oil Products Co., the process is a continuous, non-regenerative C_4 or C_5 process using aluminum chloride catalyst deposited on a solid support with hydrogen chloride as a promoter. Catalyst (in a low cost form) concentration on the support is maintained by aluminum chloride addition to a feed stream. Reactor conditions are 200-350 psig and 180-220° F. With n-C_4 feed, 50% conversion is obtained, and with n-C_5 feed, 60%. Hydrochloric acid is returned to the reactor from a product acid stripper. Product is caustic washed before going to storage or fractionation.

A distinctive feature of the process is that the reactor effluent is fractionated to recover $AlCl_3$ along with some normal butane which is recycled to the reactor.

Literature references include:

(1) Chenuck, J. A. et al, "Butane Isomerization UOP Process," *Chem. Engrg. Prog.*, May 1947, pp. 210-218
(2) Murphy, G. B., "Catalytic Isomerization . . . Supply," *Nat. Pet. News*, Dec. 24, 1941, pp. R-401-402
(3) *Pet. Ref.*, "Process Handbook," Sept. 1952, p. 176

Available engineering services for UOP Aluminum Chloride Isomerization:
PROC DESIGN: *3, 6, 8, 17, 22,* 23, *25, 29, 32, 36, 40, 47, 48,* 49, *52,* 56, *58,* 62, *72, 78*
MECH ENGRG: *3, 6, 8, 17, 22,* 23, *25, 36, 39, 40, 47, 48,* 49, *52, 56, 58, 59,* 62, *66,* 72, *73, 78*
CONSTR: *3, 6, 8, 17, 22,* 23, *25,* 28, *29, 32, 36, 39, 40, 47, 48,* 49, *52, 56, 58, 59,* 62, *66,* 72, *73, 79*

Phillips Catalytic Isomerization

Licensed by Phillips Petroleum Co., this is a continuous, fixed-bed, vapor-phase C_4 isomerization process using aluminum chloride (deposited on bauxite) catalyst with HCl catalyst promotor.

HCl, upon recovery is recycled, and fresh catalyst is sublimed into vaporized feed for deposit on bauxite carrier. Conversions up to 50% per pass occurs in the pretreater and reactor. The bauxite guard case retains carry-over $AlCl_3$.

An acid recovery system returns fresh and recycle HCl to the feed and removes non-condensable material. Mixed butanes are caustic washed, sand filtered, and separated in a splitter. High purity isobutane goes to storage or alkylation. Normal butane splitter-stream has "pentanes-plus" removed before being recycled to raw feed.

Literature references include:

(1) *Pet. Ref.* "Process Handbook," Sept. 1956, p. 253

Available engineering services for Phillips Catalytic Isomerization:
PROC DESIGN: *8, 17, 22, 23, 25,* 33, *36, 48, 52,* 54, 56, *58, 62*
MECH ENGRG: *17, 22, 23, 25, 36, 39, 48, 52, 56, 58, 62, 73*
CONSTR: *8, 17, 22, 23, 25,* 28, *36, 39, 48, 52, 56, 58, 62, 73, 79*

ALKYLATION

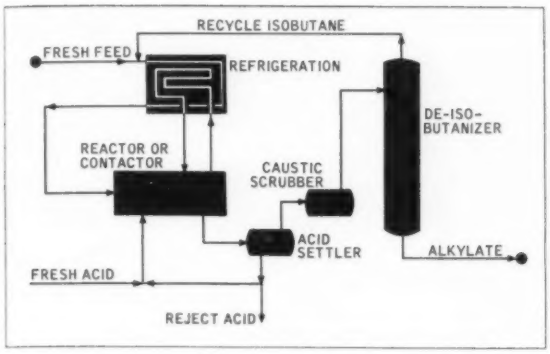
Recent developments in alkylation have been directed toward high-octane motor-fuel blend-stock as well as aviation gasoline. Units designed exclusively for motor-fuel are less expensive since effluent separation is simplified. Installation costs of $500/bbl debutanized product have been reported for small units.

The alkylation reaction as practiced in petroleum refining is the union of an olefin (ethylene, propylene, butylenes, and amylenes) with isobutane to yield high octane branched-chain hydrocarbons. Olefin feed stock sources are light ends of cracking and reforming units. Unsaturates may also be produced by dehydrogenation. Isobutane is recovered from refinery gases or produced by catalytic butane isomerization. Important in the reaction is a high isobutane-olefin ratio and unit design is directed to this end.

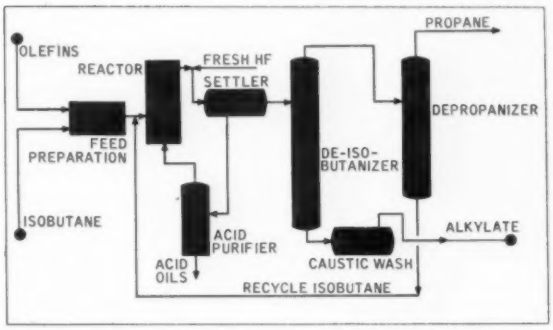
Alkylation can be accomplished as a thermal, thermal catalytic, or catalytic reaction.

Thermal catalytic alkylation combines ethylene or propylene with isobutane at 125 to 450° F and 300 to 1000 psig in the presence of metal halide catalysts such as aluminum chloride.

Catalytic alkylation combines olefins (C_3, C_4 and C_5) with



Typical sulfuric acid alkylation flow diagram



Typical hydrofluoric acid alkylation flow diagram

isobutane in the presence of an acid catalyst (sulfuric, hydrofluoric) at low temperatures and pressures (30-105° F and atmospheric to 150 psig). Alkylate yields are 150-178% based upon olefin feed, and depend upon olefin molecular weight. Debutanized motor fuel alkylate ranges from 90 to 95 F-1 Octane clear and as high as 106 leaded. Road performance characteristics are excellent with little or no depreciation of Research Octane.

Commercial application has been mainly catalytic. The sulfuric acid process was introduced in the United States in 1938. HF alkylation was introduced by Phillips Petroleum Co. in December of 1942 and developed rapidly for wartime needs.

General literature references include:

(1) Caesar, P. D. and A. W. Francis, "Mechanism of Low Temperature Alkylation of Iso-Paraffins," *Nat. Pet. News*, Oct. 1, 1941, pp. R308 and R310
(2) Foster, A. L., "Anhydrous HF Tomorrow's Refining Process Catalyst," *Oil & Gas J.*, Jan. 7, 1943, p. 125
(3) Foster, A. L., "Lost Factors in Post-War Alkylation," *Oil & Gas J.*, Oct. 27, 1945, pp. 96-97, 119-120, 123-124
(4) Foster, A. L., "Facts and Possibilities of Alkylation and Isomerization Processes," *Oil & Gas J.*, April 15, 1943, pp. 71, 81, 83, 85-86, 88
(5) Gard, E. W., et. al., "Alkylation and Its Influence on Utilization of Natural Gasoline," *Oil & Gas J.*, Dec. 14, 1939, pp. 42-43, & *Oil & Gas J.*, Dec. 21, 1939, pp. 46-48
(6) Garrison, A. H., "Alkylation Plant Takes Olefins Left by Selective Polymerization," *Nat. Pet. News*, June 12, 1946, pp. R212-213, R216, R219
(7) Hewson, J. E., "HF Alkylation," *Oil & Gas J.*, Mar. 22, 1954, p. 189
(8) Kunkel, J. H., "HF Alkylation Unit Placed on Stream in Record Time," *Pet. Engr.*, Sept., 1944, p. 80
(9) Mendious, W., "Alkylation Backbone of Aviation Gasoline," *Pet. Engr.*, July 1, 1945, p. 206
(10) *Nat. Pet. News*, "Anhydrous Hydrofluoric Acid; Properties as an Alkylation Catalyst," Oct. 28, 1942, pp. R-366-368
(11) *Nat. Pet. News*, "Properties of Hydrogen Fluoride as Alkylation Catalyst Described," May 27, 1942, p. R174
(12) Oden, E. C., et. al., "Propylene a Valuable Feed Stock for Alkylation," *Pet. Ref.*, Apr., 1950, pp. 103-108
(13) Parker, F. D. and E. G. Ragatz, "Refinery Processes for War Products," *Pet. Ref.*, Dec. 1943, pp. 105-115
(14) Petroleum Processing, "Alkylation Plant Improvements," July, 1951, pp. 744-748
(15) Resen, F. L., "Four Ideas that Improve Cities Service Alkylation Unit Operation," *Oil & Gas J.*, Feb. 25, 1952, pp. 178-180
(16) Scott, J. A. and R. M. Cooper, "Economic and Successful Operation Obtained at HF Alkylation Plant," *Oil & Gas J.*, Mar. 30, 1946, p. 204
(17) Simmons, J. H., "Hydrogen Fluoride, the Catalyst," *Pet. Ref.*, July, 1943, pp. 83-87
(18) Stiles, S. R., "What's New in Alkylation Process," *Pet. Ref.*, Feb., 1955, pp. 103-106
(19) Wall, J. E., "How to Improve Alkylate Feed Stock for More and Better Avgas," Petroleum Processing, Oct., 1952, pp. 1438-1443

Kellogg Sulfuric Acid Alkylation

A low temperature process employing concentrated sulfuric acid catalyst to unite olefins (propylene, butylenes, and amylenes) with isobutane to produce high octane aviation or motor fuel blend stock (101 to 106 leaded F-1 Octane).

The process licensed by M. W. Kellogg Co. uses a Cascade reactor to give: efficient contact of reactants; auto-refrigeration to control temperature; series flow of acid; isobutane reactants with parallel-flow contact with olefins; and settling zones in the reaction vessel.

Olefin feed is contacted with excess isobutane and acid and cooled to 35-45° F at 5-15 psig and split into equal streams before being charged to the various agitated reaction zones of the Cascade unit. Isobutane rich recycle and refrigerant streams are introduced in the first reaction zone and pass in series flow through succeeding zones. Reaction temperatures are controlled by continuous refrigeration. Vapors are withdrawn from the top of the reactor, compressed and returned to the first reaction zone. Spent acid is withdrawn from the bottom of the settling zone while hydrocarbons spill over a baffle into a special withdrawal section. Effluent is caustic and water washed before being successively depropanized, deisobutanized and debutanized. Alkylate can then be rerun to produce aviation grade blend stock.

Early installations utilized a jet-type reactor system requiring four reactors in parallel and almost three times as much isobutane recycle for the same alkylate make. The Cascade design has also reduced all auxiliary equipment needs. Acid consumption has been lowered to 0.6 lb/gal alkylate for a yield of 172 vol % of butylene feed.

Literature references include:

(1) Bolles, W. L., "Alkylation Commands New Interest from Refiners," *Pet. Ref.*, Sept., 1951, pp. 150-151
(2) Borthick, G. D., et. al., "Two Step Approach to Alkylation Efficiency," *Oil & Gas J.*, June 4, 1956, p. 88
(3) *Chem. Engrg.*, "H_2SO_4 Alkylation Pictured Flow Sheet," Sept., 1951, pp. 212-215
(4) Jewell, J. W. and C. C. King, "Sulfuric Acid Alkylation for Gasoline," *Oil & Gas J.*, Aug. 16, 1951, p. 120
(5) *Pet. Ref.*, "Improvements in Sulfuric Acid Alkylation Process," Feb., 1951, p. 93+
(6) Sager, F., "Sulfuric Acid Refining in the Production of Aviation and Motor Fuel," *Pet. Ref.*, June, 1946, pp. 127-130

Available engineering services for Sulfuric Acid Alkylation:
PROC DESIGN: 3, 6, *11*, 13, *22*, 23, *40*, 48, 49, 52, *58*, *62*, 70, 71, 78
MECH ENGRG: 3, 6, 8, *11*, 13, *22*, 23, *39*, *40*, 48, 49, 51, 52, *58*, *62*, 70, 71, 78
CONSTR: *3*, 6, 8, 11, 13, *22*, 23, 28, *39*, *40*, 48, 49, 52, *58*, *62*, 70, 71, 78

Perco HF Alkylation

Licensed by Phillips Petroleum Co., this process uses regenerable hydrofluoric acid as a catalyst to unite olefins (propylene, butylenes, and amylenes) with isobutane to produce high octane blend stock. Leaded motor fuel alkylate from butylene feed will make 105 Research Octane.

Bauxite dried charge is intimately contacted with acid at 60-

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

100° F and an optimum internal isobutane-to-olefin ratio of 6 to 1. The mixture is separated in a settler and acid is returned to the reactor. An acid side-stream is continuously regenerated to 92% purity by fractionation. HF consumption is about 0.20 lb/bbl alkylate produced, and is removed with acid soluble oils.

The hydrocarbon fraction from the settler is deisobutanized and alkylate is caustic-washed prior to motor fuel storage. In aviation fuel operation, the alkylate would also be debutanized and rerun before storage. Propane is separated from the isobutane fraction, acid stripped, and caustic washed before storage. Isobutane is recycled to the feed stream.

Literature references include:

(1) Bolles, W. L., "Alkylation Commands New Interest from Refiners," *Pet. Ref.*, Sept. 1951, 150-151
(2) Findley, R. A., "Mechanical Operation of HF Alkylation Units," *Nat. Pet. News*, May 2, 1944, R326-328, R386 & R388
(3) Frey, F. E., "Commercial Alkylation with Hydrogen Fluoride Catalyst," *Chem. & Met. Engrg.*, Nov. 1943, 126-128
(4) *Nat. Pet. News*, "Special Catalyst Handling Equipment Provided in HF Alkylation Plant," June 2, 1943, R-243-244
(5) Peters, W. D. & C. L. Rodgers, "New Alkylation Process," *Pet. Ref.*, Sept. 1955, 126+
(6) Resen, F. L., "Revamping an HF Alkylation Unit," *Oil & Gas J.*, July 7, 1952, 84+
(7) Thornton, D. P. Jr., "HF Alkylation Today," PETROLEUM PROCESSING, May 1951, 488-491

Available engineering services for Phillips HF Alkylation:
PROC DESIGN: 3, 8, *17, 23, 25, 29,* 32, 33, *36, 40,* 46, 49, *52,* 54, 56, *58,* 62
MECH ENGRG: 3, 8, *11, 17,* 21, *23, 25, 36, 39, 40,* 46, 49, *52, 56, 58, 62, 66, 73*
CONSTR: 3, 8, *11, 17,* 21, *23, 25,* 28, *29,* 32, *36, 39, 40,* 46, 49, *52, 56, 58, 62, 66, 73, 76, 79*

UOP Alkylation

The process licensed by Universal Oil Products Co. An employing regenerable hydrofluoric acid as a catalyst to unite olefins (propylene, butylenes, and amylenes) with isobutane. Recent modifications are tailored to motor fuel production.

Dried charge is contacted with acid at 60-100° F. Recycle isobutane provides optimum isobutane-olefin ratio. The reaction mixture is separated in a settler. Acid is purified by distillation and returned to the reacton zone. The hydrocarbon effluent is stabilized to a desired RVP, water-washed, and taken to storage. Isobutane is recycled.

Leaded alkylate ranges from 100-106 Research Octane, depending upon feed stock.

UOP units have also been designed using sulfuric acid catalyst.

Literature references include:

(1) Bolles, W. L., "Alkylation Commands New Interest from Refiners," *Pet. Ref.*, Sept. 1951, pp. 150-151
(2) Gerhold, C. G. et al., "Development of Hydrogen Fluoride Alkylation Process," *Pet. Engr.*, July 1, 1944, p. 256+
(3) Linn, C. B. & A. V. Grosse, "Alkylation of Isoparaffins by Olefins in Presence of Hydrogen Fluoride," *Ind. & Engrg. Chem.*, Oct. 1945, pp. 924-929
(4) *Nat. Pet. News*, "AvGas Supply Enlarged Through HF Alkylation," Apr. 29, 1942, p. R131-R132
(5) Orr, A. R., "Why Cosden Chose HF Alkylation," *Oil & Gas J.*, Aug. 1, 1955, pp. 102-104
(6) Shanley, W. B. & H. J. Nebeck, "Numerous Improvements in HF Alkylation Will Cut Costs and Reduce Losses," *Oil & Gas J.*, Dec. 1, 1945, pp. 94-96, 98
(7) Thorton, D. P. Jr., "Three Unusual Features in New HF Alkylation Unit," PETROLEUM PROCESSING, Oct. 1954, pp. 1570-1573
(8) Wheeler, H. K. Jr. & R. H. Judice, "HF Alkylation Unit Revamp Contributes to Scrap Drive," *Pet. Engr.*, Dec. 1952, C5-8, C10

Available engineering services for UOP Alkylation:
PROC DESIGN: 3, *6, 8, 17, 22,* 23, *25,* 29, 32, 33, *36,* 38, *40, 47, 48,* 49, *52,* 56, *58,* 62, 70, *72,* 78
MECH ENGRG: 3, *6, 8, 17,* 22, 23, *25, 36, 38, 39, 40, 46,* 47, *48,* 49, 50, *52, 56, 58,* 59, 62, 66, 70, *72, 73,* 78
CONSTR: 3, *6, 8,* 17, 22, 23, *25,* 28, 29, 32, *36, 38, 39, 40, 46,* 47, *48,* 49, *52, 56, 58,* 59, 61, 62, 66, 70, *72, 73,* 78, *79*

Effluent Refrigeration Alkylation

Effluent refrigeration is a modification to sulfuric acid alkylation to maintain a high isobutane-olefin feed ratio and is licensed by Stratford Engineering Corp. (also licensor for conventional sulfuric acid alkylation). Reactor effluent is used as a refrigerant to control reaction temperature (45-50° F) and at the same time to separate isobutane for recycle. The system can be used along with a conventional deisobutanizer to give up to 10:1 isobutane to olefin ratio in the reactor feed. Internal isobutane ratios are 700-1000, with 68-75 vol % isobutane provided from the hydrocarbon reactor effluent.

Fresh, prepared olefin feed is contacted with acid in a liquid phase. Pressure is held at 40 psig or higher in the reactor and settler. Leaving the settler, the effluent is discharged to a suction trap and pressure is regulated to 3-5 psig. Self-cooling to 20-30° F is effected by vaporization of isobutane. Suction trap liquid regulates reaction temperature by passing through coils of Stratco reactor and more isobutane is vaporized. Isobutane vapors are separated from liquid, compressed, depropanized, and pass to the feed as recycle along with isobutane from conventional fractionation.

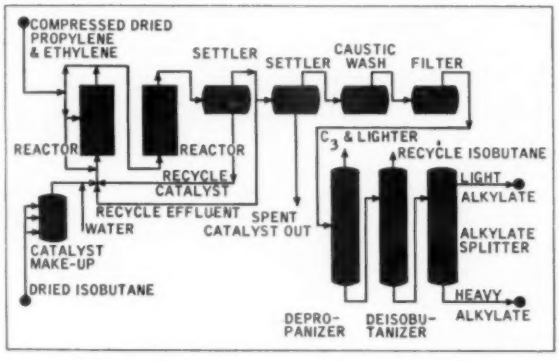
The Texas Co. at Amarillo, Texas, built and operated the first effluent refrigeration unit early in 1954. Thirteen plants are either now operating or will be in the near future. Effluent refrigeration may be applied to existing plants as well as new construction.

Literature references include:

(1) Goldsby, A. R. and D. H. Putney, "Texas Company's Amarillo Plant Uses Improved H_2SO_4 Alkylation Process," *Oil & Gas J.*, Sept. 19, 1955, pp. 104-107
(2) Putney, D. H., "Many Improvements Noted in Alkylation Plant Design," *Pet. Ref.*, June, 1951, pp. 89-94
(3) Putney, D. H. and O. J. Webb, "Sulfuric Acid Alkylation," *Pet. Ref.*, Sept., 1953, pp. 105-109
(4) Templeton, P. C. and B. H. King, "Sulfuric Acid Alkylation with Effluent Refrigeration and Its Effect On Refinery Operations," Western Petroleum Refiners Assn., Wichita, Kan., June 21-22, 1956

Available engineering services for Effluent Refrigeration Alkylation:
PROC DESIGN: *3, 6,* 8, *11, 17,* 22, 23, 33, *36,* 47, 49, *52, 56, 58, 62,* 71, *72*
MECH ENGRG: *3, 6,* 8, *11, 17,* 22, 23, *36, 39,* 47, *49, 52, 56, 58, 62,* 71, *72, 73*
CONSTR: *3, 6,* 8, *11, 17,* 22, 23, 28, *36, 39,* 47, *49, 52, 56, 58, 62, 71, 72, 73*

Diisopropyl Alkylation (Aluminum Chloride)



Licensed by Phillips Petroleum Co., this is a liquid-phase process to convert ethylene, propylene and isobutane to high octane blending stock in the presence of an aluminum chloride hydrocarbon-complex catalyst. Hydrochloric acid is used as a catalyst promotor.

Dried feed stock is passed through two agitated reactors in a series at about 120° F. Catalyst is added to the system by passing isobutane feed through a catalyst make-up drum. Catalyst promotor (HCl) concentration is maintained by injecting a controlled amount of water into the reactor. Settlers separate the catalyst from the effluent for recycle to the reactors and also provide hydrocarbon recycle to control reaction temperature. Effluent is then caustic washed, filtered, and fractionated to remove first propane, then isobutane for recycle. Normal butane may be removed before alkylate is split into light and heavy fractions.

The process was first installed by Phillips and was operated during World War II to provide aviation gasoline blend stock. First large scale manufacture was started August 1944 at Phillips, Tex.

Alkylate containing high percentages of diisopropyl is char-

acterized by excellent blending properties and a high response to tetraethyllead.

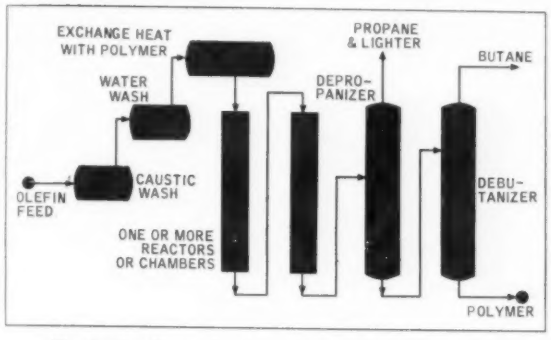
Literature references include:

(1) Alden, R. C. et al, "The Story of Diisopropyl," *Oil & Gas J.*, Feb. 9, 1946, pp. 70-73+
(2) Blunck, F. H. & D. R. Carmody, "Catalytic Alkylation of Isobutane with Gaseous Olefins," *Ind. & Engrg. Chem.*, March 1940,, pp. 328-330.
(3) Ipatieff, V. N., "Catalytic Refining Trends," *Oil & Gas J.*, Mar. 30, 1939, p. 86+
(4) Ipatieff, V. N. & A. V. Grosse, "Action of Aluminum Chloride on Paraffins," *Ind. & Engrg. Chem.*, Apr. 1936, p. 461

Available engineering services for Phillips Aluminum Chloride Alkylation:

PROC DESIGN: *3, 6, 8, 17, 23, 25,* 33, *52,* 54, 56, *58, 62*
MECH ENGRG: *3, 6, 8, 11,* 12, *17, 23, 25, 39, 52, 56, 58, 62, 73*
CONSTR: *3, 6, 8, 11, 17, 23, 25,* 28, *39, 52, 56, 58, 62, 73, 79*

POLYMERIZATION



Typical polymerization process flow diagram

A continuous, catalytic conversion of olefin gases to liquid condensation products. Feed preparation is for propylenes and butylenes from cracking as a mixed feed for motor gasoline production; or selective olefins for codimer, tetramer and other special products. Feed is usually caustic and water washed to remove sulfur and nitrogen compounds.

The treated, olefin-rich feed stream is contacted with catalyst (copper pyrophosphate, phosphoric acid) at 300-425°F and 150-1200 psig, depending upon feed stock and product requirement. The reaction is exothermic and temperature is usually controlled by heat exchange. Stabilization and/or fractionation systems separate saturated and unreacted gases from the product. Conversion of 90-97 % of olefins is obtained for motor gasoline operation. Research octane is 93-99 clear.

Catalytic polymerization, originally developed by Universal Oil Products Co., came into use in the middle 1930's and became one of the first catalytic processes of the Petroleum Industry. The first commercial plant started operations March 1937 at the Shamrock Oil & Gas Corp. in Texas. Development was rapid during World War II for special critical products.

Recent trends are to reserve butylenes for alkylation rather than polymerization because of the superiority of isoparaffins over olefins in the automotive engine. Most new construction will probably be paid-out on the basis of special polymers from propylene.

General catalytic polymerization references include:

(1) Beychock, M. R., "How to Control Poly Plant Recycle," Petroleum Processing, Dec. 1951, pp. 1403-4
(2) Egloff, G., "Polymer Gasoline," *Ind. Engrg. Chem.*, Dec. 1936, pp. 1461-7
(3) Ipatieff, V. N., "Aviation Gasoline by Polymerization and Alkylation of Cracked Gases," *Chem. & Engrg. News*, Nov. 10, 1942, pp. 1367-8
(4) McAllister, S. H., "Catalytic Polymerization of Butylenes by Sulfuric Acid," *Oil & Gas J.*, Nov. 12, 1937, pp. 139-40
(5) Norman, H. S., "Steady Increase in Production of Polymerized Motor Fuels," *Oil & Gas J.*, Nov. 25, 1937, p. 29
(6) Steffens, J. H., et al., "Correlation of Operating Variables in Catalytic Polymerization," *Chem. Engrg. Prog.*, Apr. 1949, pp. 269-78
(7) Sutherland, R. E., and J. L. Doegey, "Economics of Alkylation & Polymerization for Producing High Grade Gasoline," Petroleum Processing, June 1949, pp. 679-80

California Polymerization

Licensed by California Research Corp., and Hydrocarbon Research Inc., a process to convert C_3 and/or C_4 olefins to high octane motor fuel, or propylene and benzene to cumene.

Catalyst is phosphoric acid on quartz chips and may be prepared in place in the reactor section. Regeneration consists of washing and steam drying quarts, contacting with acid in the reactor, and draining the excess acid.

Reaction temperatures and pressures for gasoline operation are 300-375° F and 150-600 psig. Heat of reaction is controlled by adding recycle saturates to the feed. Olefin conversions of 90-95 wt % are obtained, yielding 93 (C_3 olefin) to 99 (C_4 olefins) F-1 clear octane debutanized polymer.

First unit built in 1937. A California Polymerization reference is:

(1) Langlois, G. E. and J. E. Walkey, "Improved Process Polymerizes Olefins for High Quality Gasoline," *Pet. Ref.*, Aug. 1952, pp. 79-83

Available engineering services for California Polymerization:

PROC DESIGN: 3, 8, *17,* 22, 23, *25,* 28, 29, 33, *36,* 38, *40,* 47, *49, 52,* 56, 58, *62*
MECH ENGRG: 3, 8, *17,* 22, 23, *25,* 28, 29, *36,* 38, *39, 40, 46,* 47, *49, 52,* 56, 58, *62,* 66
CONSTR: 3, 8, *17,* 22, 23, *25,* 28, 29, *36,* 38, *39, 40, 46,* 47, *49, 52,* 56, 58, *62,* 66, *79*

Phosphoric Acid Condensation

Chamber and Reactor Types, licensed by Universal Oil Products Co., a process to catalytically convert propylenes and/or butylenes to high octane gasoline or petrochemical polymers.

Pellet kieselguhr impregnated with phosphoric acid catalyst is used in either a chamber or tubular reactor. Exothermic reaction temperature is controlled in the chamber type by using saturates separated from the effluent as recycle to the feed and as quench between catalyst chamber beds. Tubular reactors are temperature controlled by water or oil circulation around the catalyst tubes.

Reaction temperatures and pressures are 350-435° F and 400-1200 psig. Conversion to motor gasoline (95 F-1 clear octane or better) is from 90 to 97 wt % of olefin charge.

Olefins and aromatics may be united by alkylation for special applications at 400-550° F and 400-900 psig. A rerun column is required in addition to the usual fractionating.

Phosphoric Acid Condensation references include:

(1) Cotton, E., "New Gulf Polymerization Unit in Port Arthur, Texas Plant," *Oil & Gas J.*, May 18, 1939, p. 119+
(2) DeLoach, D. C., "Catalytic Polymerization Unit is a Feature of McMurrey Improvement Plan," *Oil & Gas J.*, Sept. 30, 1948, pp. 74-75
(3) Egloff, G., "Catalytic Production of Polymer Gasoline," *Oil & Gas J.*, Mar. 19, 1936, pp. 140-42
(4) Egloff, G., "Mechanisms of Olefin Polymerization," *Nat. Pet. News*, Nov. 20, 1935, pp. 65-72
(5) Egloff, G., "Polymerization a Tool of Great Economic Utility," Nat. Pet. News, Nov. 20, 1935, p. 25+
(6) Egloff, G., et al., "Motor Fuels from Polymerization," *Oil & Gas J.*, Nov. 12, 1937, p. 176
(7) Faust, P. H., "What Takes Place in Polymerization," *Pet. Ref.*, July 1944, pp. 99-104
(8) Ipatieff, J. N., U. S. Patents 1,993,513 and 2,001,909 (1935)
(9) Ipatieff, J. N., and B. B. Corson, U. S. Patent 2,113,654 (1938)
(10) Ipatieff, J. N., and B. B. Corson, "Refining Gasoline with Solid Phosphoric Acid Catalyst," *Ind. & Engrg. Chem.*, Nov. 1938, p. 1317
(11) Loehler, W. A., "Polymerization and Its Economics," *Chem. & Met. Engrg.*, Aug. 1938, p. 412
(12) Leenhouts, W. J., "Johnson Midget Polymerization Unit," *Oil & Gas J.*, Mar. 9, 1939, pp. 65-66
(13) O'Donnell, J. P., "Midget Poly Plant Uses Combined Feed," *Oil & Gas J.*, Aug. 24, 1939, pp. 59-60

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

(14) O'Donnell, J. P., "Exothermic Reactions Supply Entire Heat Requirements for Poly Units," *Oil & Gas J.*, June 29, 1939, p. 52
(15) *Oil & Gas J.*, "Sunray Makes a Codimer and Polymer Gasoline in Tandem Units," Nov. 4, 1943, p. 34
(16) Sanders, T. P., "Wilshire Completes First Polymerization Unit on West Coast," *Oil & Gas J.*, Sept. 2, 1937, p. 48
(17) Shanley, W. B., and G. Egloff, "Midget Polymerization," *Oil & Gas J.*, May 18, 1939, p. 119
(18) Van Voorhees, M. G., "Cooperative Catalytic Poly Plant Operates at 1100 to 1200 Pounds," *Tech. Sect. Nat. Pet. News*, Jan 28, 1939, p. R270
(19) Weinert, P. C., and G. Egloff, "Catalytic Polymerization and Its Commercial Applications," PETROLEUM PROCESSING, June 1948, pp. 585-6

Available engineering services for UOP Phosphoric Acid Polymerization:
PROC DESIGN: *3*, *5*, *6*, *8*, *22*, 23, *25*, *28*, *29*, 32, 33, *36*, *40*, 46, 47, *48*, 49, 52, 56, 58, 62, 70, 72, 78
MECH ENGRG: *3*, *6*, *8*, *11*, *17*, *22*, 23, 25, *28*, *29*, 32, *36*, *39*, *40*, 47, *48*, 49, 52, 56, 58, 59, 62, 66, 70, *72*, *73*, 78
CONSTR: *3*, *6*, *8*, *11*, *17*, *22*, *23*, *25*, *28*, *29*, 31, 32, *36*, *39*, *40*, 46, 47, *48*, 49, 52, 56, 58, 59, 62, 66, 70, 72, *73*, *79*

Polyco Catalytic Polymerization

Licensed by M. W. Kellogg Co., a process to convert propylenes and/or buytlenes to high octane motor fuel or selective feed to special products (codimer, tetramer, etc.).

Catalyst, a pelleted form of copper pyrophosphate, is contained in the tubes of a heat exchanger type reactor. Heat of reaction is controlled by water or oil circulation around the tubes. Chamber reactors are also used employing saturated hydrocarbon recycle for reaction temperature control.

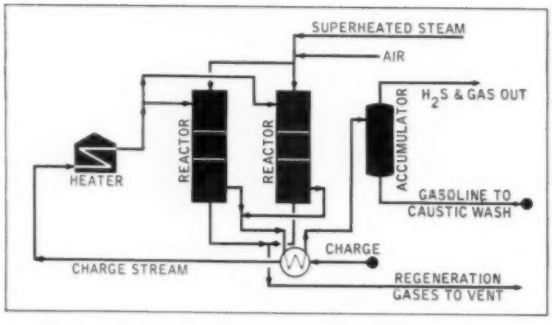
Reaction temperatures and pressures are 300-400° F and 750-900 psig. Feed is heated by exchange with reactor effluent. Conventional fractionation is employed to yield LPG products along with gasoline. With mixed feed operation, yield of 2.0 lb RVP polymer of 96-98 clear F-1 octane is about 90 % of olefin charge.

Polyco Catalytic Polymerization references include:

(1) Raithruff, P. F., U. S. Patent 2,189,655
(2) Van Voorhees, M. G., "Sohio Polymerization Unit First Using New Catalyst," *Tech. Sect., Nat. Pet. News*, Jan. 26, 1940, p. R230
(3) Waddel, J. D., "Finish Years Operation of New Type of Polymerization Unit," *Oil & Gas J.*, Aug. 28, 1941, pp. 45-46

Available engineering services for Polyco Catalytic Polymerization:
PROC DESIGN: *28*, 33, *52*, *58*
MECH ENGRG: *8*, *28*, *39*, *52*, *58*
CONSTR: *8*, *28*, *39*, *52*, *58*

DESULFURIZATION



Catalytic Desulfurization—general flow diagram

Early desulfurization processes were similar to clay treating, but with more severe operating conditions. Bauxite or fuller's earth type catalyst desulfurize naphthas and light distillates, but middle and heavy distillates are treated with difficulty (cause catalyst coking) and an unstable product is yielded.

The process is generally operated at low pressure and temperatures in the 700° F range. No attempt is made to hydrogenate, although a small amount of naphthene reforming takes place which supplies some hydrogen for desulfurization. The main effort is to crack the carbon-sulfur bond, but some hydrocarbons are also cracked.

This type of process is being abandoned in favor of desulfurization employing the hydrogen treating principle. Because of the low cost of catalyst and simplicity, the process is still used to advantage in special isolated refining situations.

Cycloversion Desulfurization

Licensed by Phillips Petroleum Co., Cycloversion is a continuous, fixed-bed, catalytic process to desulfurize straightrun or cracked gasoline, kerosine and other light fractions.

Catalyst may be optionally regenerated with air and steam at about 1200° F. Some units use single reactors and discard catalyst when spent. Bauxite catalyst has a life of 5000-20,000 bbl/ton in non-regenerative service, and as high as 100,000 bbl/ton when regenerated.

Feed is vaporized and passed over catalyst at from 650 to 850° F and pressures up to 50 psig. Space velocity is in the order of 1 v/v/hr. All sulfur compounds except cyclic ones may be decomposed, forming hydrogen sulfide, and are eliminated mainly with vent gas. Remaining hydrogen sulfide may be removed by caustic washing.

Product loss is 0.5-2.0%. Light straight-run products are almost completely desulfurized while heavier cracked gasoline desulfurization is in the order of 40-60%.

The main application for Cycloversion was originally cracking (980-1020° F and 70-90 psig) and reforming (950-1050° F and 50-200 psig). The same equipment was used as for desulfurization, but with rerun and stabilization facilities. Most of these units have been converted to desulfurization service or are shutdown.

The first Cycloversion unit was installed in 1940.

Literature references include:

(1) Broomer, G. M. & M. W. Conn, "Recent Advances in Perco Catalytic Desulfurization," *Oil & Gas J.*, Oct. 26, 1946, pp. 96-98, 115-121
(2) Buell, A. E. & B. Skinner, "Catalytic Cracking of Texas Panhandle Gas Oil by Cycloversion Process," *Oil & Gas J.*, May 5, 1945, p. 87
(3) Buell, A. E. & P. M. Waddill, "Conversion of Thermal Cracking to Cycloversion," *Pet. Ref.*, Oct. 1944, pp. 83-87
(4) Daniels, V. W. & M. W. Conn, "Perco Cycloversion for the Small Refiner," PETROLEUM PROCESSING, May 1947, pp. 391-397
(5) Goldtrap, W. A. and Bradley Skinner, "Refinery Cycloversion for Premium Fuels," *Pet. Engr.*, Apr. 1945, pp. 174-179, 182
(6) Helmers, C. J. et al., "Cycloversion Process," *Oil & Gas J.*, Dec. 13, 1947, p. 88
(7) *Oil & Gas J.*, "Cycloversion," Mar. 22, 1947, p. 151
(8) Pew, J. E. & A. E. Buell, "Catalytic Desulfurization Solves a Problem in High Sulfur Distillate," *Nat. Pet News*, Oct. 2, 1940, pp. R354-358
(9) Schultze, W. A. & R. C. Alden, "Catalytic Desulfurization to Improve Aviation Blending Naphthas," *Ref. & Nat. Gaso. Mfr.*, Nov. 1939, pp. 96-98
(10) Schultze, W. A. & C. J. Helmers, "Gas Oil Cracking by the Cycloversion Process," *Oil & Gas J.*, Apr. 13, 1944, pp. 225-235

Available engineering services for Cycloversion:
PROC DESIGN: *8*, *23*, *25*, 29, 32, *36*, *48*, *52*, 54, 56, *58*, *62*
MECH ENGRG: *8*, *23*, *25*, *36*, *39*, *48*, *52*, 56, *58*, *62*
CONSTR: *8*, *23*, *25*, *29*, *32*, *36*, *39*, *48*, *52*, 56, *58*, *62*, *79*

Gray Catalytic Desulfurization

Developed by the Gray Processes Corp. licensor until Dec. 1952, present process patents are held by the Pure Oil Co. This is a fixed-bed catalytic desulfurization process for gasoline and light distillates, using a solid adsorbent type catalyst such as fuller's earth. The process is continuous with two reactors in alternate regenerating and treating operation.

Gasoline vapors are passed through the catalyst bed at 700-750° F at pressures depending on the system. Space velocity depends upon feedstock and desulfurization required. The product stream is cooled and gas is separated. Final product treatment may include a caustic wash after stabilization to remove traces of hydrogen sulfide.

When desulfurizing cracked gasoline, conventional clay pretreatment is needed for the most economical catalyst life—in the range of 1200 bbls/ton.

Literature references include:

(1) Amero, R. C. and W. H. Wood, "Catalytic Desulfurization of Cracked and Straight-Run Gasolines," *Oil & Gas J.*, May 24, 1947, p. 82
(2) Martin, A. M. L. Carlson, "Catalytic Desulfurization by Use of the Gray Process," *Oil & Gas J.*, March 26, 1942, pp. 138-144

THERMAL PROCESSES

Thermal processes as described here are those which decompose, rearrange or combine hydrocarbon molecules by the application of heat without the aid of catalysts.

Commercial decomposition processes are designed to prevent coke formation as much as is practical (Viscosity Breaking or Thermal Cracking), or to control the process operation whereby coke can be recovered as a marketable product (Coking). Molecular rearrangement to affect octane improvement of virgin naphtha feed can be accomplished through the thermal reforming process.

The major variables involved in thermal processing are type of feed, time, pressure and temperature. Compounds of equal molecular weight can be listed in order of decreasing tendency to crack as follows: paraffins, olefins, di-olefins, naphthenes, and aromatics. Heavier fractions generally are easier to crack than lighter fractions. Yield of light products increases with an increase in the time of reaction. Speed of reaction decreases with increase in reaction time. Pressure is a secondary variable. Its principle effect is to retain the heavier oil molecules in the zone of cracking at the temperature of decomposition as well as to control molelcular density, thereby aiding heat transfer. The primary variable temperature ranges from 700-1100°F to accomplish decomposition at sufficiently high reaction rates for commercial processes.

Catalytic cracking and reforming for increasing gasoline production and upgrading virgin naphtha quality have replaced their thermal counterparts in most of the present day refineries. Coking, however, is growing in importance and the existing thermal processing units are playing an important supporting and supplementary role in today's refining picture.

THERMAL CRACKING

Thermal conversion processes designed to increase the yield of gasoline obtainable from crude either directly—through production of thermal gasoline components from heavy charge—or indirectly—through production of gas oil (through viscosity breaking operation) suitable for catalytic cracking charges, and through production of light olefins suitable for polymerization charge. Thermal cracking processes can also be classified as to the physical state—mixed (or liquid) phase and vapor phase—in which the cracking mechanisms are carrried out. Whether the cracking reactions are carried out in mixed or vapor phase depends upon the nature of the feed and the pressure and temperature conditions. Originally vessel construction imposed limits on these latter variables.

The advantages claimed for vapor phase processes are: (1) higher antiknock value of the motor fuel (more olefins), (2) relatively low installation cost, (3) elimination of pressure with consequently more safety appeal, and (4) adaptability to low boiling range distillates which cannot be economically cracked in the liquid phase.

The advantages for liquid phase cracking can be summarized as follows: (1) lower fixed gas production, (2) easier treatment of product gasoline (more paraffinic fuel component), and (3) relatively lower fuel consumption.

Numerous thermal cracking processes—both mixed and vapor phase—have been patented and utilized by the industry since the first commercial cracking unit was placed on stream at the Whiting Refinery of the Standard Oil Co. of (Ind.) in March 1913 (Burton pressure distillation process). No attempt will be made to describe herein each and every thermal process since the role of these processes in present day refinery flow is of little or no significance.

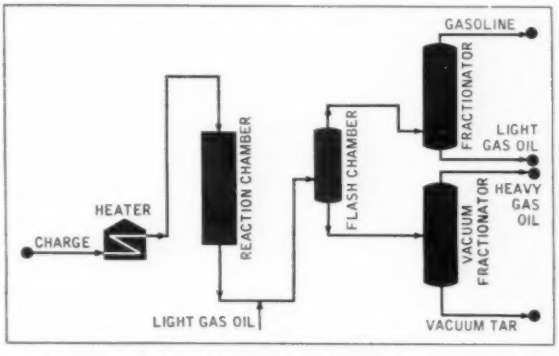
The thermal cracking process was utilized initially to convert heavier charge oil into gasoline material. However, today it is almost impossible to justify economically the installation of thermal cracking facilities for gasoline production because of the current market demands for high antiknock gasoline products. Existing thermal cracking units are being employed for cracking heavy catalytic cycle stocks that would usually go to fuel oil.

General reference on thermal cracking include:

(1) Armistead, Jr., G., "Thermal Cracking of Residual Feed Stocks to Liquid Residues," *Oil & Gas J.*, April 19, 1947, pp. 94-115
(2) Arnold, P. M., "Olefin Production by Thermal Cracking of Isobutane," *Oil & Gas J.*, July 7, 1945, pp. 87-99
(3) Burges, A. E., "Talco Refinery Designed Primarily for Producing Asphalt," *Pet Engr.*, Dec. 1937, p. 53
(4) Clark, C. L., "Design of Cracking-Still Tubes," *Oil & Gas J.*, Jan. 8, 1942, pp. 33-4
(5) Ferris, S. W., "Limiting Compositions in Hydrocarbon Conversion," *Ind. & Engrg. Chem.*, June 1941, pp. 752-59
(6) Faust, P. H., "What Takes Place in Thermal Cracking," *Pet. Ref.*, Jan. 1943, pp. 66-8
(7) Mithoff, R. C., and L. F. Schimansky, "Reaction Chambers on Thermal Cracking Units," American Petroleum Inst., San Francisco, Calif., Nov. 1941
(8) Nelson, W. L., "Cracking Yields from Heavy Charge Stocks," *Oil & Gas J.* July 22, 1948
(9) Nelson, W. L., "Pressure Drop in Pipestills—Effect of Distillation Range of Charge Stock," *"Oil & Gas J.*, June 24, 1948, pp. 323
(10) Nelson, W. L., "Cracking Temperature of Hydrocarbons," *Oil & Gas J.*, Mar. 18, 1948, p. 120
(11) Nelson, W. L., "Flashing Cracking Plant Residuum," *Oil & Gas J.*, Aug. 25, 1945

Available engineering services for Thermal Cracking:
PROC DESIGN: *3, 6,* **8,** *17, 22,* 23, *25,* 29, 32, *40,* 47, *48,* 49, 50, 52, *54, 56, 58,* 62, 70, 72, 78
MECH ENGRG: *3, 6,* 7, **8,** *11,* 14, 17, *22,* 23, *25, 39, 40,* 47, *48,* 49, 52, *54, 56, 58,* 59, 62, *66,* 70, 72, *73,* 78
CONSTR: *3, 6,* **8,** *11, 17, 22,* 23, *25,* 28, 29, 32, *39, 40,* 47, *48,* 49, 52, *56, 58,* 59, 61, 62, *66,* 70, 72, *73, 79*

Viscosity Breaking



A comparatively mild type thermal cracking process employed for the reduction of viscosity, boiling range and pour point of heavy straightrun residuum charges. Lighter distillate stocks can also be charged. Gasoline yield from viscosity breaking is affected by gravity of the feed, amount and characteristics of the gas oil removed, and gravity and end—point of the desired gasoline product.

Operating conditions for a typical reduced crude feed are

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

935°F and 50 psig at the furnace outlet. Exit temperature of the reaction chamber is reduced to 835°F by injection of light gas oil.

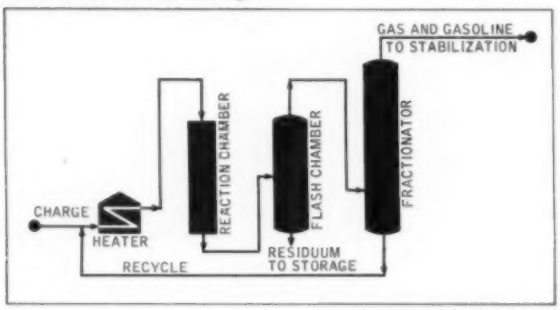
Cracked products from the reaction chamber are fed to a flash distillation chamber. Vapor overhead is separated into a light distillate overhead product and light gas oil bottoms in a fractionator. Liquid products from the flash chamber pass to a vacuum fractionator, which yields a heavy gas oil distillate and a residual tar.

Viscosity breaking references include:

(1) Allen, J. G., D. M. Little and P. M. Waddill, "Visbreaking High Vacuum Residua," American Inst. of Chem. Engrs., Kansas City, May 1951 (reviewed in PETROLEUM PROCESSING, June 1951, pp. 612-5
(2) Allinder, F. S., "Handling Reduced Crudes," *Pet. Ref.*, Nov. 1955, pp. 197-200
(3) *Chem. Engrg.*, "Two New Petroleum Advances," July 1951, pp. 196-98
(4) Egloff, G., and R. F. Davis, "Viscosity Breaking," Modern Petroleum Technology, The Institute of Petroleum, London, 1954

Available engineering services for Viscosity Breaking:
PROC DESIGN: 1, 8, *11*, 23, *25*, 32, 40, 47, *48*, 49, *56*, *58*, 62, 70, 78
MECH ENGRG: 7, *8*, 11, 22, 23, *25*, *39*, 40, 47, *48*, 49, *52*, *56*, *58*, 59, 62, 70, 78
CONSTR: *8*, 11, 22, 23, *25*, 32, *39*, 40, 47, *48*, 49, *52*, *56*, *58*, 59, 62, 70, *79*

Mixed Phase Cracking



A continuous thermal decomposition process for conversion of heavy products to gasoline boiling components. In general, mixed phase (also called liquid phase) cracking processes employ rapid heating of the charging stock (kerosine, gas oil, reduced crude or whole crude)—after which it is passed to a digester or reaction chamber, and then to a vapor separation tower where the vapors are cooled. Overhead from the flash chamber is sent either to a fractionating tower for specification gasoline components or to a condenser (pressure distillate) for eventual redistillation. Fractionating tower bottoms are recycled and flash chamber bottoms are withdrawn as heavy fuel.

Pressure in mixed phase cracking is normally held at 350 psig or greater to maintain a homogeneous phase and thereby eliminate coke formation in the tubes. Temperatures range between 750-900°F, depending on the nature of the charge. A high ratio of liquid to vapor is maintained, and increasing temperature necessitates increase in pressure to prevent excessive vaporization.

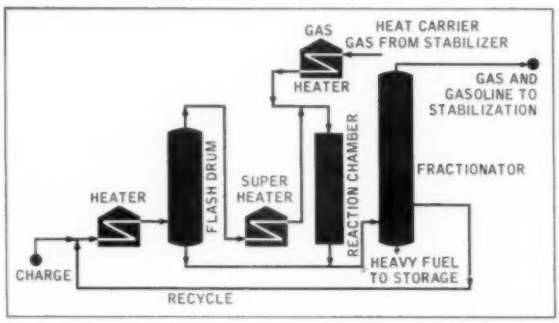
Historically, the term cracking is almost as old as the industry itself. An article in 1869 by S. F. Peckham described an increase in illuminating oil yield through cracking operations. Commercially, cracking as a process had its beginning in 1913 at Whiting, Ind.—the Burton Process of Standard Oil Co. (Ind.) Since then, developments have been made continuously in improving or making this process more adaptable to specific needs. These developments are too numerous to describe in detail.

Mixed phase cracking references include:

(1) Boelter, L. M., and R. H. Kepner, "Pressure Drop Accompanying Two-Component Flow Through Pipes," *Ind. & Engrg. Chem.*, Apr. 1939, pp. 426-34
(2) Dittus, G., and J. Hildrebrand, "A Method of Determining the Pressure Drop for Oil-Vapor Mixtures Flowing Through Furnace Coils," *Trans.*, Amer. Soc. of Mech. Engrs., Apr. 1942
(3) McAdams, W. H., W. K. Woods and R. L. Bryan, "Vaporization Inside Horizontal Tubes," *Trans.*, Amer. Soc. of Mech. Engrs., Apr. 1942, p. 193
(4) McReynolds, H., and J. M. Barron, "Thermal Cracking of Fluid Catalytic Cycle Gas Oils," *Pet. Ref.*, Apr. 1949, pp. 111-116
(5) Nelson, W. L., "Density of Vapors in Cracking Oils," *Oil & Gas J.*, May 13, 1948, p. 176
(6) Nelson, W. L., "Yields in Non-Coking Thermal Cracking," *Oil & Gas J.*, Feb. 25, 1942, p. 183
(7) Nelson, W. L., "Thermal Cracking Yields and Rates," *Oil & Gas J.*, Oct. 18, 1951, pp. 145-6
(8) Nelson, W. L., "Relation of Cracking Yields to Viscosity of Cracked Fuel Oil," *Oil & Gas J.*, June 29, 1950, p. 88
(9) *Oil & Gas J.*, "UOP Reduces Royalty to 3 Cents a Barrel," Oct. 21, 1944, p. 108
(10) *Oil & Gas J.*, "Thermal Cracking Processes," Mar. 23, 1950, p. 181
(11) Uren, L. C., P. P. Gregory, R. A. Hancock and G. V. Feskov, "Flow Resistance of Gas-Oil Mixtures Through Vertical Pipes," Amer. Inst. of Mech. Engrs., Technical Publication No. 252, 1929

Available engineering services for Mixed-Phase Cracking:
PROC DESIGN: 1, *3*, *6*, *8*, *11*, *17*, 23, *25*, *32*, 40, *42*, 46, *47*, *48*, 52, 56, *58*, 62, 70, 72
MECH ENGRG: *3*, *6*, 7, *8*, *11*, *17*, 23, *25*, *39*, 40, *42*, 46, *47*, *48*, 52, 56, *58*, 62, 70, 72
CONSTR: *3*, *6*, *8*, *11*, *17*, 23, *25*, 32, *39*, 40, *42*, 46, *47*, *48*, 52, 56, *58*, 62, 70, *72*, *79*

Vapor Phase Cracking



A high temperature, low pressure thermal conversion process. Under these conditions dehydrogenation reactions increase, with the resultant higher yield of olefins and aromatics.

Operating conditions for vapor phase reactions include pressures below 50 psig, temperatures between 1000-1100°F and cracking times as low as one second. Feed stocks can vary from gaseous hydrocarbons to gas oil.

Historically, these processes were installed for gasoline production but relative process economics favored use of mixed phase units, because hard carbon was often deposited in heater tubes causing failures and because relatively larger reactors were required. Vapor phase cracking was successfully employed for the production of hydrocarbons—olefins and aromatics—for chemical manufacture.

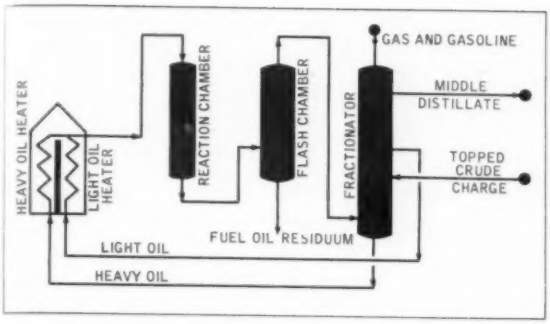
Vapor phase cracking references include:

(1) Berents, L. I., and V. E. Glushnev, "Vapor Phase Oxidizing Cracking of Oil Products," *Nat. Pet. News, Technical Section*, Nov. 1945, pp. R-912-20
(2) Lindin, H. R., and R. E. Peck, "Gaseous Product Distribution in Hydrocarbon Pyrolysis," *Ind. & Engrg. Chem.*, Dec. 1955, pp. 2470-74
(3) Linden, H. R., C. E. Brooks and L. N. Miller, "Production of Natural Gas Substitutes by Thermal Cracking of Natural Gas Liquids," *Ind. & Engrg. Chem.*, Dec. 1955, pp. 2475-78
(4) *Nat. Pet. News, Technical Section*, "Acetylene and Other War Chemicals Made by Cracking in a Regenerative Furnace," Aug. 26, 1942, pp. R-270-76
(5) Nelson, W. L., "Naphtha Cracking for Butadiene," *Oil & Gas J.*, July 8, 1948, p. 91
(6) *Pet. Ref.*, "New Ethylene Process Uses Naphtha Pyrolysis," July 1951, pp. 122-3
(7) Shultz, Jr., E. B., J. J. Guyer and H. R. Linden, "Pyrolysis of Crude Shale Oil," *Ind. & Engrg. Chem.*, Dec. 1955, pp. 2479-82

Available engineering services for Vapor-Phase Cracking:
PROC DESIGN: *1*, *6*, *8*, *11*, 13, 21, 23, *25*, *32*, 40, *42*, 43, 47, *48*, 49, 52, 56, *58*, *62*, 70
MECH ENGRG: *6*, 7, 8, 10, *11*, 13, 21, 23, *25*, *39*, 40, *42*, 43, 47, *48*, *49*, 52, 56, *58*, *62*, 70, 73
CONSTR: *6*, *8*, *11*, 21, 23, *25*, 28, *32*, *39*, 40, *42*, 43, 47, *48*, *49*, 52, 56, *58*, *62*, 70, 73, *79*

Selective Cracking

A thermal conversion process scheme wherein advantage is taken of the fact that different charge boiling ranges and/or



hydrocarbon make-up have optimum temperature, pressure, etc. conditions for efficient cracking. Refractory stocks are cracked for a long period of time or at a higher temperature. Less stable stocks are cracked at lower temperatures.

In a two coil operation, employing light and heavy oil from a toppped crude charge, the operating conditions in the heavy oil heater might be 920-960°F and 300-500 psig outlet pressure. For lighter gas oil cracking, a temperature of 950-990°F and a pressure range of 500-700 psig might be employed. When a wide-boiling range material is employed, selective cracking eliminates the accumulation of the refractory low-boiling material in the recycle when the total charge is handled at low temperatures. Likewise, this process eliminates the coke formation resulting from high temperature cracking of the high-boiling material.

Relatively high yields of gasoline, middle distillate and olefinic gases are obtainable from this process. The topped or reduced crude is fed to the bottom of a fractionator, end point gasoline and middle distillate are removed as overhead and side streams, respectively, from the fractionator. From a lower side cut tray a higher boiling distillate (includes the low boiling fractions of both recycle and charge stocks) is charged to the light oil heater. The heavy bottoms from the fractionating column is the charge to the heavy oil heater.

The heaters may be separate units or separate coils in one furnace. Though more expensive, the former is preferred for ease of control. The outlet of each coil or heater enters the top of a downflow reaction chamber operating without a liquid level. Fuel oil after stripping is withdrawn from the bottom of a flash chamber.

Gasoline yields can vary between 35 and 55% for a given charge (25.0° API Mid-Continent) depending upon whether maximum furnace oil or maximum gasoline operations are being practiced in the refinery.

Universal Oil Products Co. has designed processes of this type.

(1) Holst, Jr., W. W., and A. B. Vought, "Two Stage Cracking Increases Capacity of Palembang Refinery," *Oil & Gas J.*, Dec. 30, 1937, pp. 305
(2) *Nat. Pet. News, Technical Section*, "First 3-Coil Cracking Unit in U. S. Goes on Stream at Sunray Refinery," Sept. 5, 1945, pp. R-675-8
(3) Smoley, E. R., V. Mekler, and A. H. Schutte, "Theory of Combination Selective Cracking Demonstrated by Commercial Operations," *World Pet.*, June 1937, p.94
(4) Tuttle, R. B., "Addition of One Coil Increases Cracker's Efficiency by Two-Thirds," *Oil & Gas J.*, Dec. 1, 1945, pp. 83-85.

Available engineering services for selective cracking:

PROC DESIGN: 1, *3, 6, 8, 11,* 23, *25,* 32, 38, 40, *42,* 47, *48, 52, 56, 58,* 62, 70, 72

MECH ENGRG: *3, 6,* 7, *8, 11,* 23, *25,* 38, *39,* 40, *42,* 47, *48, 52, 56, 58,* 62, 70, 72

CONSTR: *3, 6, 8, 11,* 23, *25,* 32, 38, *39,* 40, *42,* 47, *48, 52, 56, 58,* 62, 70, 72, *79*

Thermal Cracking of Naphtha

A thermal conversion process whereby select low octane fractions of catalytic naphtha are upgraded through thermal decomposition to higher quality material. The total combined catalytic and thermal—catalytic naphtha component yield a product of a quality comparable to that obtained from undercutting without the accompanying yield loss.

This process is designed to upgrade the heavy portion of catalytic naphtha which includes a portion of uncracked virgin charge stock resulting from overlapping at the crude tower fractionation.

Thermal cracking of catalytic naphtha removes naphthenes and paraffins, produces some heavy aromatics by condensation reaction, and produces a large quantity of olefins.

The use of spare thermal capacity as a remedy for reduced catalytic cracked naphtha yields or quality is an answer to those refiners confronted by the overlap problem.

This development in thermal processing is recent, having been announced in Sept. 1954 by Sun Oil Co. Extensive pilot plant work has been carried out and limited plant scale tests made. No commercial installation on a full time basis is in use as yet.

(1) McReynolds, H., and J. M. Barron, "Thermal Cracking of Fluid Catalytic Cycle Gas Oils," *Pet. Ref.*, Apr. 1949, pp. 111-116.
(2) Pollock, A. W., "Thermal Cracking of Cat Naphtha?" *Pet. Ref.*, Feb. 1955, pp. 127-28

Available engineering services for thermal cracking of catalytic reformate:

PROC DESIGN: *3 6, 8, 13, 17, 23, 25, 29, 32,* 34, 38, *40, 42, 47, 48, 52,* 56, *58, 62, 72*

MECH ENGRG: *3, 6,* 7, *8, 13, 17, 23, 25,* 34, 38, *39, 40, 42, 47, 48, 52, 56, 58, 62, 72*

CONSTR: *3 6, 8, 13, 17, 23, 25, 29, 32,* 38, *39, 40,* 42, 47, *48,* 52, *56, 58, 62, 72, 79*

COKING

Thermal processes for continuous conversion of heavy, low-grade oils into lighter products. Feed can be such material as reduced crude, straightrun pitch, cracked tars or shale oil. Primary purpose of process is to produce low carbon gas oil for catalytic cracking feed stock. Gasoline, gas and coke are secondary products. Calcination of petroleum coke can yield almost pure carbon or artificial graphite suitable for production of electrodes, motor brushes, dry cells, etc.

Basically, coking processes differ from thermal cracking processes in that reaction time of cracking is longer in the former. To accomplish this, drums, chambers or reaction vessels are employed in the coking processes. Generally, the remaining equipment is similar in coking and thermal cracking operations. Two or more coke drums or chambers are normally provided in the majority of the coking operations in order that decoking can be accomplished in those vessels not onstream without interrupting the semi-continuous nature of the process. Decoking operation has progressed from manual decoking to cable decoking and to the present day drilling and hydraulic decoking methods. Coke drums are usually operated on a 24 hours on-stream—24 hours off-stream cycle.

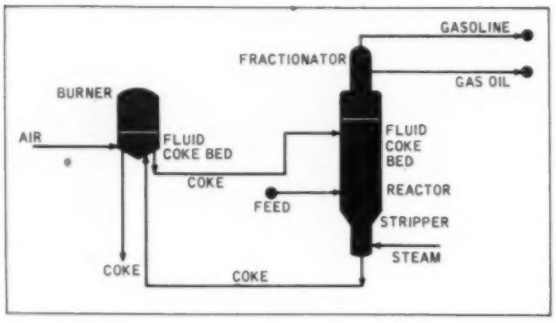
The present emphasis in thermal processing is on coking. The trend toward use of more heavy crude oils as well as the future prospect of employing shale oil and tar sands as sources of petroleum products should keep coking much in use in the future refinery operations.

General references on coking include:

(1) Alexander, G. W., "Coke Removal by Steam," *Pet. Ref.*, June 1948, pp. 301-303
(2) Armistead, Jr., G., "The Coking of Hydrocarbon Oils," *Oil & Gas J.*, Mar. 16, 1946, p. 103
(3) Court, W. F., "Hydraulic Decoking of Coke Chambers," *Oil & Gas J.*, Nov. 18, 1938, pp. 179-84.
(4) Diwoky, R. J., "Continuous Coking of Residuum by the Delayed Coking Process," *Ref. Nat. Gaso. Mfr.*, Nov. 1938, pp. 554-61
(5) Jones, D. G., "The Coking of Petroleum Residues," *Jour. of Inst. of Pet. Technologists*, July 1935, p. 895
(6) Thomas, C. L., "Petroleum Coke and Coking; Progress in Petroleum Technology," Trans., Amer. Chem. Soc., 1951, pp. 278-286
(7) Watson, K. M., "Cracking Fuel Oil to Coke," *Ref. Nat. Gaso. Mfr.*, Dec. 1938, pp. 652

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.



Fluid Coking

Thermal process utilizing the fluidized-solids technique for continuous conversion of heavy, lowgrade oils into lighter products. Coking occurs in a thin liquid film on circulating, fluidized, seed coke agitated by rising gaseous products in the reactor.

Typical feedstock is vacuum residuum, giving a product of 50-60% gas oil (430-1015° F V.T.); naphtha of about 77 RON clear; and a coke yield (including about 5 wt. % on feed burned in the heater to heat the fluid coke to the reactor) of about 1.1 to 1.3 times the conradson carbon in the feed.

Operating conditions are about 900-1050°F in the reactor at essentially atmospheric pressure. Fluid coke is preheated to about 1110-1200°F in the burner before it enters the reactor. Feed enters the reactor at 500-700°F.

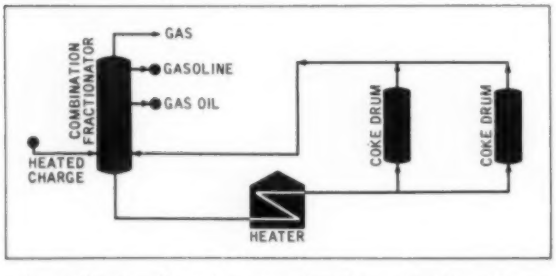
Fluid coking, newest of the petroleum coking processes, was first announced in 1953. The first commercial unit went on stream at the Carter Oil Co.'s Billings, Mont., refinery in 1954. The process is licensed by Esso Research and Engineering Co.

Fluid coking references include:

(1) Barr, F. T., and C. E. Jahnig, "Fluid Coking and Fluid Coke," Amer. Inst. Chem. Engrs., New York Section, Oct. 1954
(2) Johnson, F. B., and R. E. Wood, "Fluid Coking—Yield Studies," Western Petroleum Refiners Assn., Sept. 1954, Casper, Wyo.
(3) Martin, H. Z., F. T. Barr, and R. W. Krebs, "The Fluid Coking Process," Western Petroleum Refiners Assn., Mar. 1954, San Antonio, Texas
(4) Petroleum Processing, "Coke and Lighter Products from Low-Grade Oils by Fluid Coking," PDS No. 5, Mar. 1956, pp. 135-7
(5) Petroleum Processing, "Fluid Coke can Compete for Fuel and Metallurgical Coke Markets," Nov. 1954, p. 1664
(6) Petroleum Processing, "New Fluid Coking Process," Sept. 1953, pp. 1316-7
(7) Thornton, D. P., Jr., "Why Carter Likes Its Coker," Petroleum Processing, June 1955, pp. 840-5
(8) Voorhies, A., Jr., and H. Z. Martin, "Fluid Coking of Residua," Amer. Pet. Inst., Nov. 1953, Chicago, Ill.—reviewed in Petroleum Processing, Dec. 1953, pp. 1880-1
(9) Voorhies, A., Jr., "The Fluid Coking Process: From Pilot Plant to Large-Scale Application," Calif. Nat. Gaso. Assn., Apr. 1955, Los Angeles, Calif.

Available engineering services for Fluid Coking:
PROC DESIGN: *6, 8, 13, 17, 22, 23, 25, 29, 40,* 49, 52, *58, 62*
MECH ENGRG: *6, 7, 8, 13, 17, 22, 23 25, 39, 40,* 49, 52, *58, 62*
CONSTR: *6, 8, 17, 22, 23, 25,* 28, *29, 39, 40,* 49, 52, *58, 62, 79*

Delayed Coking



A continuous thermal process for the conversion of any type reduced crude to cracking feed stock.

Feed is heated through exchange or direct fired heating and charged to a fractionating tower. Tower bottoms are pumped through a pipe furnace and discharged to insulated coke drums. Vapors overhead from the drums are sent to the fractionating tower for separation into product streams of coker gas, gasoline and gas oil. Depending upon desired distribution yield of products, operation can be recycle or single pass.

Furnace design is such as to minimize coke formation in the tubes. Steam generation is often practiced to recover some of the heat in the fractionation tower.

Typical yields for a 15-20° API gravity reduced crude charge having 6.0% conradson carbon are 65-75% gas oil, 15-20% gasoline, and 12-17 wt. % coke. The normal range of operating conditions for delayed coking units are: 900-940°F, furnace outlet temperature; 780-840°F, coke drum temperature, and 10-70 psig, coke drum pressure.

Numerous delayed coking unit designs are available, differing primarily in the equipment design, which in many instances is tailored to the exact demands of a given refining situation. Delayed coking units have been constructed and/or designed by, Foster Wheeler Corp., M. W. Kellogg Co., Lummus Co. and Union Oil Co. of Calif.

References for Foster Wheeler-designed delayed coking units include:

(1) *Oil & Gas J.*, "Delayed Coker and Pour Reduction," Mar. 23, 1950, p. 185
(2) *Pet. Ref.*, "Delayed Coking," Sept. 1952, pp. 148-9
(3) "Thermal Delayed Coking," Foster Wheeler Bulletin No. O-46-1, pp. 12-13

References for Kellogg-designed delayed coking units include:

(1) Jewell, J. W., Jr., and J. P. Connor, "Economics of Petroleum Coking for 'Cat Cracking' Feed Preparation," Amer. Inst. of Chem. Engrs., Tulsa, Oct. 1950—reviewed in Petroleum Processing, Nov. 1950, pp. 1199-1202
(2) Maass, Randal, and R. E. Lauterbach, "Delayed Coking Unit Processes Residuum Into Gas Oil Charge for TCC Unit," Petroleum Processing, Jan. 1947, pp. 11-16
(3) *Pet. Ref.*, "The Kellogg Delayed Coking Process," July 1953, pp. 108-9

References for Lummus-designed delayed coking units include:

(1) Fuchs, O. A., "New 420 Ton/Day Delayed Coking Unit," Petroleum Processing, Oct. 1950, pp. 1058-62
(2) Kasch, J. E., and E. W. Thiele, "Delayed Coking," *Oil & Gas J.*, Jan. 2, 1956, pp. 89-90
(3) *Oil & Gas J.*, "Delayed Coking," March 19, 1956, p. 169
(4) *Pet. Ref.*, "Lummus Delayed Coking Process," July 1953, pp. 102-3

References for Union Oil-designed delayed coking units include:

(1) Deal, J. M., "How Union Gets Top Octanes From Two California Plants," *Oil & Gas J.*, Mar. 19, 1956, pp. 195-211
(2) Stormont, D. H., "Union Whips Heavy Crude Bugaboo," *Oil & Gas J.*, April 11, 1955, pp. 76-7
(3) Wilson, G. M., "New Refinery Begins with Coker," *Pet. Ref.*, July 1955, pp. 149-50

Available engineering services for Delayed Coking:
PROC DESIGN: *8, 22, 23, 25, 40,* 47, 49, *52, 58,* 62, *70,* 78
MECH ENGRG: *7, 8,* 22, 23, *25, 39, 40,* 47, *49, 52, 58,* 62, *70,* 78
CONSTR:: *8,* 22, 23, *25,* 28, *39, 40,* 47, *49, 52, 58, 62, 70*

Decarbonizing

A thermal conversion process designed to maximize coker gas oil production and minimize coke and gasoline yields. Flow is essentially the same as that for delayed coking.

Compared to conventional delayed coking, however, decarbonizing is operated at essentially lower temperatures and pressures. Operating pressures range from 10-25 psig. Heater outlet temperatures range from 900-910°F and coke drum top temperatures between 775-785°F.

Yields for a 26° API gravity East Texas reduced crude (4.0% carbon residue) were 5.6 vol. % gasoline, 90.6 vol. % gas oil and 5.0 wt. % coke. For a Mid-Continent reduced crude charge (12.2% carbon residue—14.4° API gravity) yields were 13.0 vol. % gasoline, 70.4 vol. % gas oil, and 16.5 wt. % coke.

Decarbonizing units have been designed by the Blaw Knox Co., Pittsburgh, Pa. The first commercial unit was installed for the McMurrey Refining Co., Tyler, Texas in May 1954.

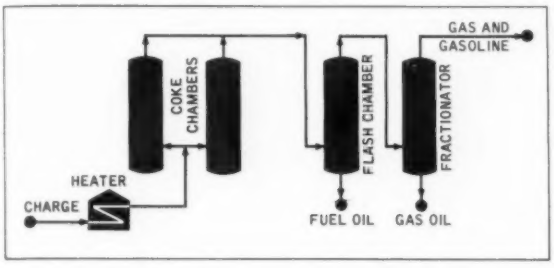
Decarbonizing references include:

(1) Eppard, J. H., W. J. Sims, and F. D. Parker, "Reducing Fuel Oil by Residuum Coking," *Pet. Ref.*, July 1953, pp. 98-101

(2) Farrar, G. L., "Gasoline Production Rises to 60%—Decarbonizing Process Improves Flexibility," *Oil & Gas J.*, Mar. 21, 1955, pp. 205-07
(3) *Pet Ref.*, "The Blaw-Knox Decarbonizing Process," July 1953, pp. 106-7

Available engineering services for Blaw-Knox Decarbonizing:
PROC DESIGN: 6, *58*
MECH ENGRG: 6, 7, *39*, *58*
CONSTR: 6, 28, *39*, *58*

Low Pressure Coking



A thermal conversion continuous process designed for once through, low pressure operation. This process is similar to delayed coking operation except that no recycle is normally practiced and coke chamber operating conditions are 25 psig and 815°F.

Water is added to the coking heater feed to prevent furnace coking. Effluent from the coking chambers passes into a flash chamber. The bottoms therefrom is a small amount of heavy fuel, the overhead is the feed to the fractionator for separation into gas oil and gas and gasoline overhead.

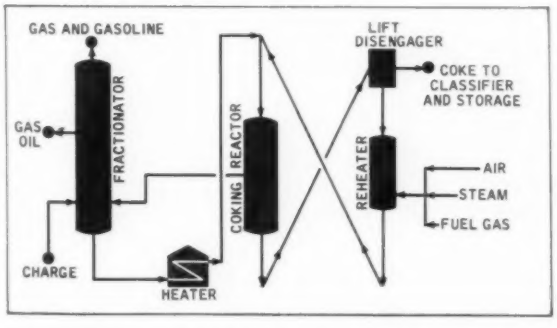
Hydraulic decoking and a gantry crane coke handling system is incorporated in the process design of the unit installed in the McPherson, Kan., refinery of Nat. Co-op. Refinery Assn., placed on stream in Nov. 1953. Design work was handled by the Universal Oil Products Co.

Low pressure coking references include:

(1) Ward, J. W., and J. M. Holocek, "Chamber Coking at NCRA," *Pet. Ref.*, Feb. 1954, pp. 157-9

Available engineering services for UOP Low Pressure Coking:
PROC DESIGN: *8*, *23*, *32*, *40*, *48*, 49, *52*, *56*, *58*, 62, 72, 78
MECH ENGRG: *7*, *8*, *17*, *23*, *39*, *40*, *48*, 49, *52*, *56*, *58*, *59*, 62, *66*, 72, *73*, 78
CONSTR: *8*, *17*, *23*, 28, *32*, *39*, *40*, *48*, 49, *52*, *56*, *58*, *59*, 62, *66*, 72, *73*, *79*

Continuous Contact Coking



A thermal conversion process employing the mass-flow lift principle to give continuous and smooth coke circulation. Pelleted coke along with gas, gasoline and gas oil are products of this process.

Oil wetted coke particles (seed coke) flow downward as a dense bed in the reactor wherein cracking, coking and drying reactions take place. Circulating coke is raised in temperature in the reheater to supply the heat of reaction and also sensible heat to the feed. Reactor pressure powers the dense unagitated coke through the lift line to the disengager section. Products are separated in a conventional fractionator. The ratio of oil to coke for normal operation is 1 lb of oil per 14 lb of coke circulated.

An average reactor temperature of 955°F and 35 psig pressure is employed for a 19.0° API gravity reduced crude charge (11.7% conradson carbon). The yields obtained were: 22.0 wt. % gasoline (76.5 RON clear), 51.0 wt. % gas oil and 12.5 wt. % coke.

The process was developed and is licensed by the Lummus Co., New York. No commercial units are in operation in this country.

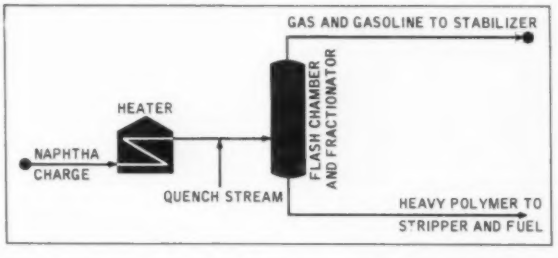
Continuous contact coking references include:

(1) Mekler, V., A. H. Schutte, and T. T. Whipple, "The Lummus Continuous Contact Coking Process," Amer. Pet. Inst., Chicago, Nov. 1953—reviewed in PETROLEUM PROCESSING, Dec. 1953, pp. 1882-3
(2) *Pet. Ref.*, "Lummus Continuous Contact Coking," July 1953, pp. 104
(3) Schutte, A. H., and W. C. Offutt, "Continuous Contact Coking," PETROLEUM PROCESSING, July 1949, pp. 769-75
(4) Smoley, E. R., and A. H. Schutte, "Continuous Contact Coking of Heavy Charge Material," Athabasca Oil Sands Conference, Canada, Sept. 1951—reviewed in PETROLEUM PROCESSING, March 1952, pp. 348-9

Available engineering services for Continuous Contact Coking:
PROC DESIGN: 47, 50, *58*, *62*
MECH ENGRG: 7, *39*, 47, *58*, *62*
CONSTR: *39*, 47, *58*, *62*

OTHER THERMAL PROCESSES

Thermal Reforming



A continuous thermal process to convert, through molecular rearrangement, low antiknock quality gasolines and naphthas into high-octane gasoline components. Secondary products of the process include olefin gases for polymerization (not produced in catalytic reforming processes), and a heavy polymerized tar for heavy fuel usage. Thermal reforming equipment is similar to that employed in thermal cracking operation. With slight modification refiners have often employed the same equipment for these two processes.

Similar to the catalytic reforming feed, a typical charge is a virgin naphtha having an initial boiling point between 200-250°F and a final boiling point varying between 300-400°F. Natural gasoline and cracked material have also been employed as charge. A temperature of 950-1100°F at a pressure of 400-1000 psig is reached at the exit of the heating section. A naphtha sidestream from the fractionator is added to the heater effluent for quenching purposes to arrest too-extensive decomposition reactions.

The thermal reforming process, except for that capacity employed as supplementary to catalytic reforming operation, has been almost completely replaced by catalytic reforming.

Process units have been designed by the Universal Oil

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

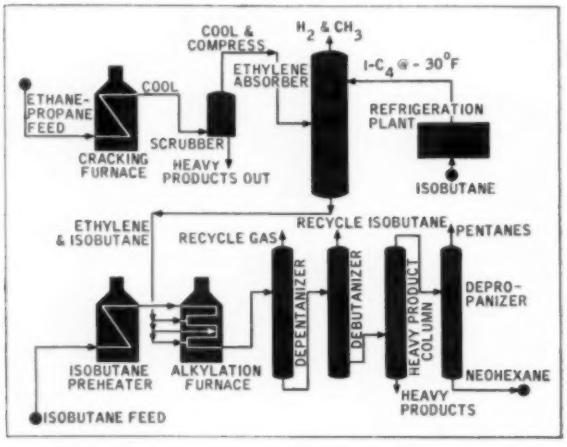
Products Co., Des Plaines, Illinois.

Thermal reforming references include:

(1) Egloff, G., "Thermal Reforming for Olefin Production," *Oil & Gas J.*, July 29, 1944, pp. 157-63
(2) Feuchter, C. F., "Economies of Thermal Reforming," PETROLEUM PROCESSING, April 1949, pp. 682-6
(3) Gary, W. W., and N. R. Adams, "Economics of Reforming and Leading Mid-Continent Gasoline," Western Petroleum Refiners Assn., Hot Springs, Ark., April 1937
(4) Haensel, V., and M. J. Sterba, "Comparison of Platforming and Thermal Reforming," Advances in Chemistry Series—No. 5, 1951, pp. 60-75
(5) Mase, R. P., and N. C. Turner, "Thermal Reforming Plus Catalytic Polymerization," Western Petroleum Refiners Assn., Wichita, Kans., April 1940
(6) Nelson, W. F., "Octane Number of Reformed Naphthas," *Oil & Gas J.*, Dec. 13, 1947, p. 118
(7) PETROLEUM PROCESSING, "Improving Yields of Gasoline, Distillates from Pennsylvania Grade Crude Oil," April 1948, pp. 329-34
(8) *Pet Ref.*, "Thermal Reforming Unit Improves Naphtha Octane Rating," Dec. 1946, p. 141
(9) Read, D., "Cracking and Thermal Reforming," *Oil & Gas J.*, Mar. 4, 1948, pp. 72-74
(10) Tighe, H. F., "Method for Correlating Thermal Reforming Yield Data with Operating Conditions," PETROLEUM PROCESSING, Oct. 1948, pp. 986-92

Available engineering services for Thermal Reforming:
PROC DESIGN: *3, 6,* 7, 8, *13, 17,* 22, 23, *25, 29,* 32, 34, *36,* 38, *40,* 43, 46, 47, *48,* 49, 50, 52, 56, *58,* 62, 70, *72,* 78
MECH ENGRG: *3, 6,* 8, *13, 17,* 22, 23, *25,* 31, 34, *36,* 38, *39, 40,* 43, 46, 47, *48,* 49, 52, 56, *58,* 59, 62, 70, *72,* 78
CONSTR: *3, 6,* 8, *13, 17,* 23, *25,* 28, *29,* 31, 32, *36,* 38, *39, 40,* 43, 46, 47, *48,* 49, 52, 56, *58,* 59, 61, 62, 70, *72, 79*

Neohexane Alkylation



A non-catalytic alkylation process developed by Phillips Petroleum Co. utilizing ethylene and isobutane as reactants to form neohexane. Ethane and propane are cracked to provide ethylene feed.

The process is not limited to neohexane and, by using different paraffin and/or olefin feeds, a variety of blending stocks may be produced.

A mixture of ethane and propane is cracked at about 1400° F and 6-8 psig for optimum ethylene formation. Gas products are freed of material heavier than C_2's by scrubbing, followed by compression and cooling. Ethylene is then absorbed by liquid isobutane at −30°F, and hydrogen and methane are removed from the system. This mixture is compressed to 4000-5000 psig and added, at ten points in the alkylation furnace, to a preheated (950° F) and compressed (4000-5000 psig) isobutane stream. Ratio of isobutane to ethylene is maintained at 9 or more to 1 in the reaction zone. Liquid yield is 70 wt % based upon ethane-propane and isobutane consumed. Neohexane content of the liquid is 30-40%. Effluent is pressure-reduced, depropanized, debutanized, relieved of heavy products, and finally dependentanized.

Neohexane is characterized by excellent aviation fuel blending properties and a high response to tetraethyllead. The material has a RVP of 9.5, a boiling point of 121° F, and an ASTM octane of 95.

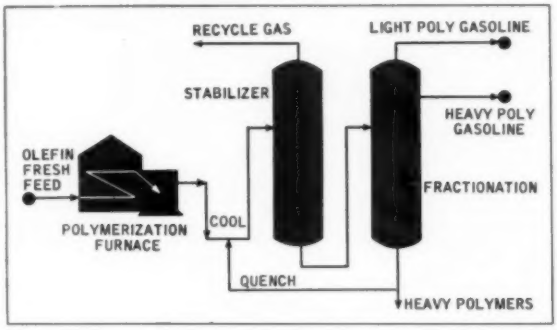
The process was developed and installed commercially in early 1940. Operation continued until 1944.

Literature references include:

(1) Frey, F. E., "Motor Fuel Isoparaffins by Thermal Gas Polymerization," *Oil & Gas J.*, Jan. 7, 1937, p. 40+
(2) Frey, F. E. & H. J. Hepp, "Non-Catalytic Addition of Ethylene to Paraffin Hydrocarbons," *Ind. Engrg. Chem.*, Dec. 1936, p. 1439+
(3) Oberfell, G. G. & F. E. Frey, "Thermal Alkylation & Neohexane," *Oil & Gas J.*, Nov. 23, 1939, p. 50+ and Nov. 30, 1939, p. 70+

Available engineering services for Thermal Alkylation:
PROC DESIGN: 6, *8, 11, 13, 25,* 32, *38, 52, 58, 62*
MECH ENGRG: 6, *8, 11, 13, 25, 38, 39, 52, 58, 62*
CONSTR. 6, *8,* 11, *13, 25,* 28, 32, *38, 39, 52, 58, 62, 79*

Thermal Polymerization



A process to convert C_4 and lighter gases from field and refinery sources into liquid condensation products. This process is particularly applicable to natural gasoline plants, etc. with excessive propanes and butanes.

Olefins are produced by thermal decomposition and polymerized by heat and pressure. Liquid feed, under a pressure of 1200-2000 psig, is pumped to a furnace and heated to 975-1100° F. Furnace effluent is cooled, stabilized, and polymer gasoline is separated by fractionation. Gas from the stabilizer is returned to vapor recovery to separate C_3's and C_4's for recycle.

Polymer yield is about 10-20 % per pass of 87-88 F-1 clear octane gasoline. Based on C_3-C_4 feed, ultimate yields of poly gasoline are 50-72 wt %, and the heavy polymers or residue, 5-10%.

The thermal polymerization process developed by the Pure Oil Co. uses a single coil at high temperatures and pressure for both decomposition and polymerization. The Lummus Co. designed and installed the process.

The Unitary Thermal polymerization process was developed by Phillips Petroleum Co., Std. Oil Co. (Ind.), Std. Oil Development Co. (now Esso Research & Engrg Co.), The Texas Co. and M. W. Kellogg, and is owned by The Polymerization Process Corporation. M. W. Kellogg licensed the process. The first commercial plant was installed at the Phillips Petroleum Co. refinery at Borger, Texas, in 1933.

Thermal polymerization, as other thermal operations, is not extensively used today.

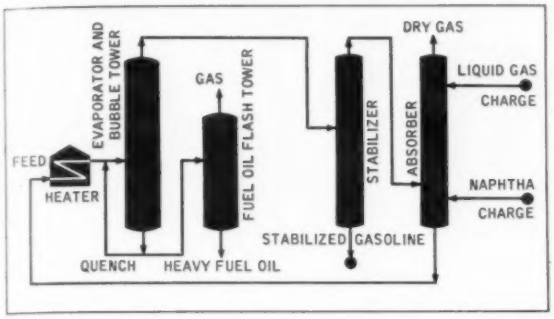
Thermal polymerization references include:

(1) Carey, J. S., "Commercial Aspects of the Unitary Thermal Polymerization Process," *Nat. Pet. News*, Nov. 4, 1936, pp. 64-71
(2) *Chem. & Met. Engrg.*, "*Polymer Gasoline,*" Nov. 1935, pp. 596, 607-8
(3) Cooke, M. B., et al., "Thermal Process for Polymerizing Olefin Bearing Gases," *Oil & Gas J.*, Nov. 14, 1935, p. 57
(4) Egloff, G., et al., "Motor Fuels from Polymerization," *Oil & Gas J.*, Nov. 12, 1937, p. 176
(5) Faust, P. H., "What Takes Place in Polymerization," *Pet. Ref.*, July 1944, pp. 99-104
(6) Foster, A. L., "Poly Unit Cuts Crude Requirements 3-4% at Atlantic Refinery," *Tech. Sect., Nat. Pet. News*, June 1, 1938, p. R259
(7) Keith, P. C., Jr., and J. T. Ward, "Thermal Conversion of Hydrocarbon Gases to Gasoline," *Nat. Pet News*, Nov. 20, 1935, pp. 52-4
(8) Koehler, W. A., "Polymerization and Its Economics," *Chem. & Met. Engrg.*, Aug. 1938, p. 412
(9) *Oil & Gas J.*, "Applications of Thermal Polymerization with Cost Data," June 22, 1939, p. 52
(10) *Oil & Gas J.*, "Operation of New Atlas Thermal Polymerization Unit Described," Mar. 19, 1936, p. 139

(11) Ridgway, C. M., and P. A. Maschwitz, "New Thermal Polymerization Unit Installed by Pure Oil," *Oil & Gas J.*, Oct. 30, 1941, p. 33

Available engineering services for Thermal Polymerization:
PROC DESIGN: *8*, 13, *25*, *29*, 32, *38*, *52*, *58*, *62*, 70
MECH ENGRG: 7, *8*, 13, *25*, *38*, *39*, *52*, *58*, *62*, 70
CONSTR: *8*, 13, *25*, *29*, 32, *38*, *39*, *52*, *58*, *62*, 70

Polyforming and Gas Reversion



Continuous thermal process for converting straightrun naphthas and/or gas oils together with extraneous light hydrocarbon gases (predominantly C_3's and C_4's) into high quality motor gasoline and fuel oil. Depending upon the charge this process is a combined operation utilizing thermal polymerization, thermal reforming, thermal alkylation, and thermal cracking.

A typical operation involves the charging of a virgin naphtha to an absorber to pick up propane (80-90% propane recovery) and heavier gases. Transfer line pressure of the mixed liquid gas-naphtha feed is 1000-1500 psig. Evaporator bottoms quench the transfer line (temperature, 1020-1120°F) to 650-700°F. The evaporator pressure is about 400 psig. Net evaporator bottoms are flashed in a flash tower yielding fuel oil as a product and gas. Evaporator overhead is routed to a stabilizer, from which condensible gases are separated from the polyform product for reuse in the absorber along with the outside liquid gas charge.

Polyforming yields for a comparable naphtha feed and quality product are about 5% higher than conventional thermal reforming.

If the gas charge is sent through a heater coil prior to mixing with the naphtha charge in the heater the process is known as the Gas Reversion process.

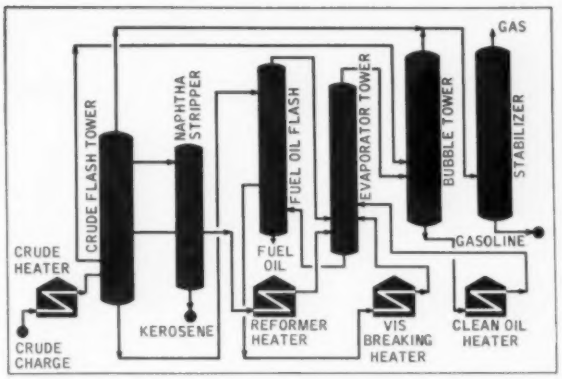
Both Gas Reversion and Polyforming processes have been essentially replaced by the modern catalytic reforming processes.

The Gas Reversion Process was developed by Phillips Petroleum Co. The Polyforming Process was developed by Gulf Oil Corp.

Polyforming and Gas Reversion references include:

(1) Bogk, J. E., P. Ostergaard, and E. R. Smoley, "The Naphtha Polyform and Gas Reversion Processes," Amer. Pet. Inst., Nov. 1940, Chicago.
(2) Cameron, D. F., and R. T. Weaver, "Still Polyforming In Your Plant?" *Pet. Ref.*, July 1955, pp. 161-4
(3) Goldtrap, W. A., and E. L. Jones, "Self-Contained Naphtha Polyforming Correlation," *Pet. Eng.*, Oct. 1948, pp. 269-72
(4) Hirsch, J. H., P. Ostergaard, and W. C. Offutt, "Correlation of Operating Variables in the Naphtha Polyform Process," Amer. Pet. Inst., Nov. 1946, Chicago—reviewed in PETROLEUM PROCESSING, Jan. 1947, pp. 61-8
(5) Offutt, W. C., P. Ostergaard, M. C. Fogle, and H. Beuther, "Naphtha Polyforming," Amer. Pet. Inst., Nov. 1946, Chicago—reviewed in PETROLEUM PROCESSING, Dec. 1946, pp. 267-76
(6) Offutt, W. C., P. Ostergaard, M. C. Fogle, and H. Beuther, "Polyforming With Outside Gas," Amer. Pet. Inst., Nov. 1946, Chicago—reviewed in PETROLEUM PROCESSING, Dec. 1946, pp. 278-88
(7) Offutt, W. C., P. Ostergaard, M. C. Fogle, and H. Beuther, "Gas Oil Polyforming," PETROLEUM PROCESSING, Oct. 1947, pp. 753-68
(8) Offutt, W. C., M. C. Fogle, and H. Beuther, "Utilization of Refinery Gases by the Polyform Process," Nat. Pet. Assn., Atlantic City, Sept. 1948—reviewed in PETROLEUM PROCESSING, Nov. 1948, pp. 1083-90

Available engineering services for Polyforming:
PROC DESIGN: *8*, *23*, *42*, 47, *52*, *56*, *58*
MECH ENGRG: *7*, *8*, *23*, *39*, *42*, 47, *52*, *56*, *58*
CONSTR: *8*, *23*, *28*, *39*, *42*, 47, *52*, *56*, *58*, *79*



Combination Units

A group of thermal conversion processes predicated upon the selective cracking principle applied to segregated charge stocks to obtain optimun product yields and quality with maximum operating flexibility. Crude running is combined with visbreaking, reforming, and thermal cracking. Other processes that might also be included in combination cracking operation are coking, vacuum flashing, selective cracking of several boiling range stocks and polymerization.

Each individual process involved in combination cracking has been described elsewhere in this glossary. Yield and operating conditions will not be repeated here. The main advantages to combining and integrating their operations include: (1) large amounts of heat—characteristic of cracking processes—can be recovered, (2) selective cracking of individual stocks at optimum operating conditions can be carried out, and (3) the general similarity of many thermal processes lend themselves to dual or multiple use of equipment, thereby eliminating duplication which inherently exists when processes are considered singularly.

Basically, the design of a combination unit varies with the specific need of the refiner. However, each unit is designed for the segregation of cracking stocks and their independent selective cracking under optimum conditions. Segregation is predicated upon charge stock boiling range and refractivity. Cracking operations are carried out in specially designed heaters to obtain maximum conversion, larger yields, and longer runs.

Process design and construction of the combination cracking process is handled by the Lummus Co.

Foster Wheeler Corp., has designed and constructed a combination unit involving the operations of distillation, visbreaking and vacuum flashing.

Combination processing references include:

(1) Al-Pachachi, N., A. Amin, M. Al-Naquib, and I. Rifat, "Combination Unit Lowers Cost at New Baghdad Refinery," PETROLEUM PROCESSING, Jan. 1956, pp. 58-61
(2) Armistead, Jr., G., "Combination Units Facilitate Refining," *World Pet.*, Nov. 1933, p. 369
(3) Nelson, W. L., "Combination Topping Plants," *Oil & Gas J.*, Dec. 23, 1944, p. 101
(4) Smoley, E. R., V. Mekler, and A. H. Schutte, "Theory of Combination Selective Cracking Demonstrated by Commercial Operations," *World Pet.*, June 1937, p. 94

Available engineering services for Combination Cracking:
PROC DESIGN: *1*, *3*, *6*, 8, *11*, *17*, 23, 25, 29, 32, 38, 40, *42*, 46, 47, *48*, 49, 50, 52, 56, *58*, 62, 66, 70, 72, 75
MECH ENGRG: *3*, *6*, 7, 8, *11*, *17*, 23, 25, 38, *39*, 40, *42*, 46, 47, *48*, *49*, 51, 52, 56, *58*, 62, 66, 70, 72
CONSTR: *3*, *6*, 8, *11*, *17*, 23, 25, 28, 29, 32, 38, *39*, 40, *42*, 46, 47, *48*, *49*, 52, 56, *58*, 61, 62, 66, 70, 72, *79*

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

SOLVENT PROCESSES

Solvent refining processes are of physical nature only, and both the desirable and undesirable constituents are recovered in their original state. Feeds to these processes are chiefly lube oil or potential lube oil blending stocks, kerosine, diesel oil and other middle distillates, and gas oil or catalytic cracking charge stocks.

Basically the processes in use today can be classified as:

(1) Treating or deasphalting—applied to full boiling materials such as gas oils and stocks from which lube cuts are made. Solvents are precipitants which divide the petroleum charge into constituents based on molecular size.

(2) Treating or refining—applied to lube boiling range charges to remove by selective extraction aromatics, naphthenes and other materials that adversely effect viscosity index. Feed to these processes has usually been deasphalted. The effluent is normally fed to dewaxing processes.

(3) Dewaxing operations—applied to lube components or full boiling material prior to final clay treating. Wax in a finish lube would result in a product of high pour point which reduces fluidity of the oil at low temperatures because of crystallization. Dewaxing operations are often combined with wax production, producing simultaneously dewaxed low pour point lube oil and high melting point, low-oil-content deoiled wax.

Historically, liquid SO_2 treatment of kerosine can be considered the forerunner of present day solvent refining methods. However, the impetus for modern lube treating came in the late 1920's and early 1930's, when the increased demand for high quality lubricating oils made it necessary to use a wider variety of crude oils for lubricating stocks—which in turn required solvent treating methods.

General solvent refining references include:

(1) Armistead, G., Jr., "Better Technology Equals Better Lube Oils," *Oil & Gas J.*, May 4, 1946, p. 115+
(2) Kalichevsky, V. A., "Modern Methods of Refining Lubricating Oils." Amer. Chem. Soc. Monograph Series, No. 76, Reinhold Publishing Corp., 1938
(3) Kalichevsky, V. A., "Modern Solvent Refining of Lubricating Oils," Petroleum Processing, Dec. 1948, pp. 1168-72; Jan. 1949, pp. 32-6; Feb. 1949, pp. 145-8; Mar. 1949, pp. 254-7; April 1949, pp. 415-21
(4) Kalichevsky, V. A., and K. A. Kobe, "Petroleum Refining With Chemicals," Elsevier Publishing Co., Amsterdam, 1956
(5) Lupfer, G. L., "Newest Solvent Lube Plant," Petroleum Processing, Jan. 1951, pp. 34-8
(6) Nolting, H. F., and R. B. Selund, "Modernized Motor Oil Facilities," Petroleum Processing, Jan. 1953, pp. 76-80
(7) Petroleum Processing, "Worlds Largest Solvent Lube Units Installed in Cit-Con Refinery," Oct. 1948, pp. 939-40
(8) Reeves, E. J., "Optimum Temperature Gradient in Selective Solvent Extraction," *Ind. & Engrg. Chem.*, July 1949, pp. 1490-2
(9) Reeves, E. J., and E. P. Hardin, "Temperature Gradient in Solvent Extraction of Lubricating Oils," *Pet. Ref.*, Jan. 1950, pp. 89-90
(10) Reman, G. H., and J. G. VandeVusse, "Applying RDC to Lube Extraction," *Pet. Ref.*, Sept. 1955, pp. 129-34
(11) Reman, G. H., and R. B. Olney, "The Rotating Disc Contactor, A New Tool for Liquid-Liquid Extraction," Amer. Inst. Chem. Engs., New York, Dec. 1954—reviewed in Petroleum Processing, Feb. 1955, pp. 230-32
(12) Smoley, E. R., "The Outlook for Lube Oils," Petroleum Processing, Aug. 1948, pp. 735-8
(13) Smoley, E. R., and D. Fulton, Modern Manufacture of Lubricating Oils," Petroleum Processing, Aug. 1947, pp. 594-608
(14) Thornton, D. P., Jr., "Pure Oils First Solvent Lube Plant Now in Operation at Smiths Bluff," Petroleum Processing, Mar. 1950, pp. 245-6

DEASPHALTING and TREATING (Gas Oil, Lube Stocks)

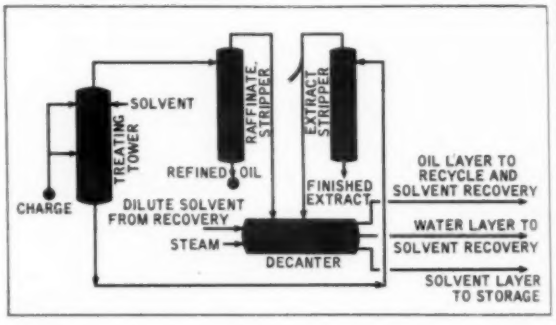
Carbon residue and coke forming tendencies of lube oil stocks, gas oils or middle distillates are reduced through the extraction or precipitant action of solvents on the asphaltic and resinous materials which are present either in solution or collodial form. Sulfur and heavy metals are removed and color improved.

Deasphalting solvents may be divided into two major groups: low molecular weight hydrocarbons, particularly propane, and oxygenated compounds, such as alcohols or esters. Deasphalting and dewaxing or extraction operations may be combined.

Many processes capable of removing asphalt from hydrocarbons were employed by the petroleum industry before solvent methods were developed. Distillation, refining with clay or sulfuric acid, and treatment with metal chlorides are the best known.

Solvent refining, when employed for preparation of feed to catalytic cracking units, can be considered in competition with vacuum distillation, coking and visbreaking. Solvent refined cracking feed approaches virgin feed in relation to its ease of processing and the characteristics of the resulting products.

Furfural Extraction—Gas Oil



A continuous extraction process for the removal of aromatics, nitrogen, sulfur, organo-metallic, acidic, and unstable compounds that affect burning quality, engine cleanliness and cetane number. Charge stocks include diesel fuel, catalytic cracking gas oil, and middle distillate burner oils. This is an outgrowth of the Furfural Refining Process employed in lube oil treating.

The extracting temperatures and solvent ratios are generally lower for gas oil than for lubricating oil charge stocks. Solvent ratios of 0.25/1.0, 0.40/1.0 and 0.80/1.0 have been employed in treating cycle oil for catalytic cracker charge, cycle oil for diesel fuel and virgin gas oil for middle distillate usage, respectively.

Yields of product raffinate are dependent upon the type and characteristics of the charge stock and the degree of quality desired. An 82.0% yield was obtained from a West Texas virgin gas oil with sulfur reduction from 1.12 to 0.49% and cetane number improvement from 53.2 to 62.9.

Following azeotropic distillations in the raffinate and extract strippers, the overhead vapors (azeotropic mixtures) from these columns are condensed and sent to a vessel for decanting. Three liquid phases separate in the decanter. The bottom phase, predominantly furfural, is returned to the solvent system. The intermediate phase, predominantly water, is charged to a tower for water removal. The light oil phase is sent to a tower for extraction of the furfural with water.

This process is licensed by the Texaco Development Corp., New York, N. Y.

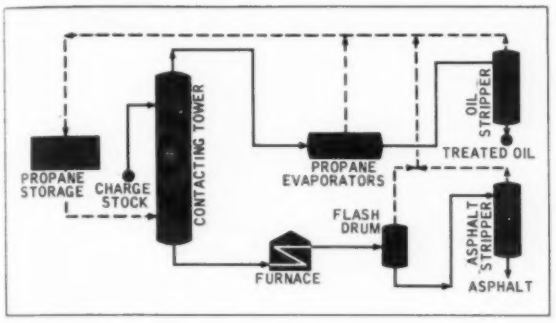
Furfural Extraction references include:

(1) Carter, R. T., "Furfural Refining Scores on Four Counts," *Oil & Gas J.*, Mar. 22, 1954, p. 157
(2) Kemp, L. C., Jr., G. B. Hamilton, and H. H. Gross, "Furfural As a Selective Solvent in Petroleum Refining," *Ind. & Engrg. Chem.*, Feb. 1948, pp 220-7

(3) *Pet. Ref.*, "Furfural Extraction of Gas Oils," Sept. 1956, p. 263
(4) Tears, C. F., "Catalytic Cycle-Stock Treating Unit," *Oil & Gas J.*, June 15, 1953, pp. 119-24
(5) Texaco Development Co., "Furfural Process Adapted to Operate on Wide Variety of Charge Stocks," *Pet. Ref.*, Sept. 1950, pp. 196-8

Available engineering services for Furfural Extraction of Gas Oils:
PROC DESIGN: *3, 6, 8, 17,* 23, *25,* 38, *40, 47, 48, 49,* 55, 58, *62, 70, 72*
MECH ENGRG: *3, 6, 8, 11, 17,* 23, *25,* 38, *39, 40, 47, 48, 49, 52,* 58, *59, 62, 70, 72*
CONSTR: *3, 6, 8, 11, 17,* 23, *25,* 28, 38, *39, 40,* 47, *48, 49, 52,* 55, 58, *59, 62, 70, 72, 79*

Propane Deasphalting



An extraction—precipitating process in which the desirable oil from the charge is dissolved in the propane solvent and the undesirable heavy metals and asphaltic materials are precipitated and separated as asphalt. Normally, vacuum reduced crude of various boiling ranges is charged for finishing into cylinder stock, bright stock or other lubricating stock.

The solubility of oil in propane decreases with increase in temperature and is greatly influenced by pressure. The solubility of asphalt in propane decreases with increase of quantity of propane employed.

Liquid propane is contacted countercurrently with descending heavy oil in the deasphalting tower. Deasphalted oil and propane overhead are separated in propane evaporators and a stripping tower. The heavy asphalt-propane mixture is heated, flashed and stripped in a tower. Propane is recovered and compressed for reuse.

Operating conditions in the deasphalting tower depend upon the boiling range of the charge and desired properties of the product. Top tower temperatures of 130-180°F are normally used at a pressure range of 400-550 psi. Temperatures around 70°F are required for wax precipitation. Propane oil ratios of 2.5/1.0 to 5.0/1.0 by volume are used for treating heavy and low viscosity residue, respectively. If stage extraction systems are employed, the solvent-oil ratio may be as high as 9.0-11.0/1.0.

Asphalt present in an oil can be either hard or soft. Pennsylvania oils contain practically no hard asphalt and their refining by propane is referred to as Propane Deresining.

Prophane Deasphalting is a widely used commercial process. It is licensed by the M. W. Kellogg Co., New York, N. Y.

Propane Deasphalting references include:

(1) Bahlke, W. H., E. W. Thiele, C. E. Adams and B. Ginsberg, "Deasphalting, Acid Treating of Lubricants with Propane," *Oil & Gas J.*, July 22, 1937, p. 44
(2) Bray, U. B., C. E. Swift, and D. E. Carr, "Use of Propane in Lubricating Oil Refining," *Pet. Ref.*, Sept. 1934, pp. 333-6, 353-9
(3) Dickinson, J. T., and N. R. Adams, "Lubricant Stocks Improved by Propane Deasphalting," *Oil & Gas J.*, Mar. 30, 1946, pp. 185-200
(4) Graff, P. T., and H. O. Forrest, "Propane Precipitation of Petroleum Resins," *Ind. & Engrg. Chem.*, Mar. 1940, pp. 294-8
(5) Hoiberg, A. J., "History, Source and General Nature of Asphaltic Bitumen," *Pet. Ref.*, Jan. 1947, pp. 1-7
(6) Livingston, M. J., and J. T. Dickinson, "Packed Towers Useful in Solvent Refining; Special Uses of Propane," *Nat. Pet. News*, July 1935, pp. 25-9
(7) McCluer, W. B., J. T. Dickinson, and H. O. Forrest, "Application of Propane to Manufacture of Pennsylvania Lubricating Oils," *Oil & Gas J.*, Nov. 18, 1938, pp. 209-10

Available engineering services for Propane Deasphalting:
PROC DESIGN: 3, *22,* 23, *25,* 38, *40,* 47, *48,* 49, *58, 60, 62,* 70, 72
MECH ENGRG: 3, 7, *22,* 23, *25, 38, 39, 40,* 47, *48,* 49, *58, 62,* 70, 72
CONSTR: 3, *22,* 23, *25,* 28, *38, 39, 40,* 47, *48,* 49, *58, 62,* 70, 72

Propane Decarbonizing

A solvent extraction process used to recover catalytic cracking feed from heavy fuel residues. Since butane, alone or with propane, can also be used as the solvent this process is often referred to as Solvent Decarbonizing. Decarbonized and demetallized oil is recovered from topped or vacuum reduced crude charge.

Process flow and equipment are essentially the same as that employed for the deasphalting of lubricating oil stocks. Extraction temperatures generally range from 150-250°F with pressures of 400-600 psi. The solvent-oil ratio and amount of temperature gradient employed are determined by feed, solvent and product characteristics and requirements. Yields of 40-75% decarbonized oil have been obtained from a reduced crude charge. The conradson carbon in the feed of 12.0-22.0 wt. % has been reduced to a range of 2.0-5.5.

Investment costs of $125-170/bbl of charge and operating costs of about 8-12¢/bbl of charge, excluding return on investment, have been claimed.

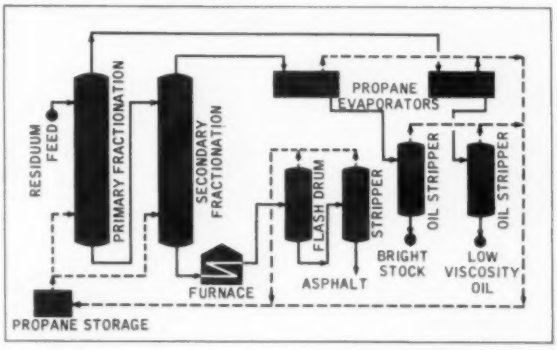
This process is licensed by M. W. Kellogg Co., New York, N. Y.

Propane Decarbonizing references include:

(1) Dickinson, J. T., and N. R. Adams, "Lubricant Stocks Improved by Propane Deasphalting," *Oil & Gas J.*, Mar. 30, pp. 185-200
(2) Kraemer, C. W., "Propane Deasphalting Process," *Oil & Gas J.*, Mar. 30, 1946, pp. 228-33
(3) Oden, F. C., and E. L. Foret, "Deasphalting Crude Residuum for Catalytic Cracker," *Ind. & Engrg. Chem.*, Oct. 1950, pp. 2088-95
(4) *Pet. Ref.*, "Decarbonizing," Sept. 1949, pp. 256-8

Available engineering services for Propane Decarbonizing:
PROC DESIGN: 23, *25,* 47, *58, 62*
MECH ENGRG: 7, 23, *25, 39,* 47, *58, 62*
CONSTR: 23, *25, 39,* 47, *58, 62*

Propane Fractionation



A continuous extraction process for the segregation of long vacuum residuum into two or more grades of lubricating oil stock. This process, employing liquid propane as the solvent, is a development of the Propane Deasphalting process. A raw heavy neutral stock and bright stock with better color, carbon residue and viscosity index properties than corresponding fractions from vacuum distillation are products of this process. Asphalt is also produced.

Residuum feed is charged to the primary tower, where it is countercurrently extracted with liquid propane. Temperature control is such that only the heavy neutral lube stock dissolves in the propane for overhead withdrawal. Propane is removed in evaporators and a steam stripper. The primary tower bottoms

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

are countercurrently extracted with propane in the secondary fractionation tower at lower temperature and pressure conditions. Bright stock is separated from propane in a manner similar to that employed for the primary tower overhead. The asphalt and propane mixture are separated after heating, flashing and steam stripping.

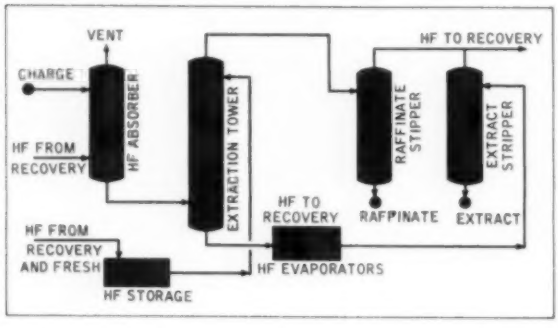
There is one commercial installation of this process on stream. It is licensed by M. W. Kellogg Co., New York, N. Y.

Propane Fractionation references include:

(1) Graff, P. T., and H. O. Forrest, "Propane Precipitation of Petroleum Resins," *Ind. & Engrg. Chem.*, Mar. 1940, pp. 294-8
(2) *Pet. Ref.*, "Propane Fractionation," Sept. 1956, p. 269
(3) Weber, G., "Pennzoil Carries Propane Fractionation to Advanced New Stage," *Oil & Gas J.*, Jan. 21, 1952, pp. 78-79, 109, 110

Available engineering services for Propane Fractionation:
PROC DESIGN: *58, 62*
MECH ENGRG: *7, 39, 58, 62*
CONSTR: *28, 39, 58, 62*

HF Extraction



A liquid-liquid extraction process for removing sulfur and coke-formers from virgin and cracked light naphthas, middle distillates and gas oils.

The charge stock, after passing through an absorber, is contacted countercurrently with liquid HF in an extraction tower. The overhead product raffinate is sent to a tower for HF removal. The solvent is recovered from the extract through use of evaporators and a stripper.

This process is relatively insensitive to variations in temperature and pressure over practical ranges. Normally 100-125°F and pressures below 100 psi are employed. Solvent to oil ratios are low, being in the range of 0.15-0.30/1.0.

HF treatment of kerosine, gas oil and cycle oil has resulted in 85-95% raffinate product yields at 60-90% desulfurization.

No commercial processes have been installed to date. The HF extraction process was developed by Standard Oil Co. (Ind.), Chicago, Ill.

HF Extraction references include:

(1) Hughes, E. C., W. E. Scovill, C. H. Whitacre, R. B. Faris, J. D. Bartleson, and S. M. Darling, "Separation of Sulfur and Aromatics from Petroleum with BF_3 and HF," *Ind. & Engrg. Chem.*, Mar. 1951, pp. 750-3
(2) Lien, A. P., and B. L. Evering, "Hydrofluoric Acid Extraction of High-Sulfur Virgin Petroleum Stocks," *Ind. & Engrg. Chem.*, Apr. 1952, pp. 874-9
(3) Lien, A. P., D. A. McCaulay, and B. L. Evering, "Extraction of Sulfur Compounds with Hydrogen Fluoride," *Ind. & Engrg. Chem.*, Dec. 1949, pp. 2698-2702
(4) *Pet. Ref.*, "H. F. Extraction," Sept. 1952, pp. 188-9
(5) Scafe, E. T., "Sulfur in Light Petroleum Products," *Pet. Ref.*, Sept. 1946, pp. 87-92

Available engineering services for HF Extraction:
PROC DESIGN: 6, *8, 17, 23, 40, 58, 62, 70, 75*
MECH ENGRG: 6, *8, 17, 23, 39, 40, 52, 62, 70*
CONSTR: 6, *8, 17, 23, 28, 39, 40, 52, 58, 62, 70, 79*

SO_2 Extraction

Continuous liquid-liquid extraction process for removing aromatic and sulfur bearing compounds from paraffinic and naphthenic charge stocks. Boiling range of the feed range between light naphtha, kerosine, gas oil, catalytic cycle oil, and high and medium lubricating oil. Other applications of this process will be described in the Lube-Treating Section (Edeleanu SO_2 Processing).

When employed for gas oil treatment, a temperature of about +60°F is employed. Yields of 65-90% resulted in 10-70% sulfur reduction and an improvement in Diesel Index at solvent-oil ratio (wt.) varying between 0.25-1.0/1.0. Treatment of catalytic cycle stock may reduce coke laydown in subsequent cracking by 50% or more.

Commercial units of this process are in existence and have been built by the Badger Process Division of the Stone and Webster Engineering Corp., Boston, Mass.

SO_2 Extraction references include:

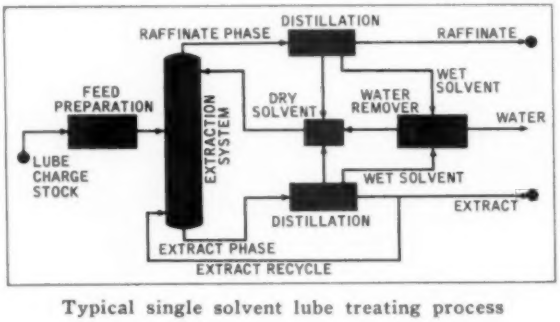
(1) Dickey, S. W., "Diesel Fuel of 50-Cetane Value Produced in New Sulfur Dioxide Extraction Plant," PETROLEUM PROCESSING, June 1948, pp. 538-42
(2) Dryer, C. G., J. A. Chenicek, G. Egloff, and J. C. Morrell, "Solvent Extraction of Diesel Fuels," *Ind. & Engrg. Chem.*, July 1938, pp. 813-21
(3) Obergfell, P., "Treatment of light Distillates by the SO_2 Extraction Process," PETROLEUM PROCESSING, June 1949, pp. 660-4
(4) *Pet. Ref.*, "SO_2 Extraction," Sept. 1956, p. 270
(5) Steffen, E., and E. Saegebarth, "The Improvement of Diesel Fuels by Extraction with Sulfur Dioxide," *Ref. & Nat. Gaso. Mfr.*, Jan. 1938, pp. 12-14
(6) Stone and Webster Engineering Corp., "Modified Edeleanu Process," *Pet. Ref.*, Sept. 1951, p. 237

Available engineering services for SO_2 Extraction of Gas Oils:
PROC DESIGN: *3, 8,* 23, *25,* 38, *48, 52, 55, 58, 62,* 70
MECH ENGRG: *3, 8,* 23, *25, 38, 39, 48, 52, 58, 62,* 70
CONSTR: *3, 8,* 17, 23, *25, 38, 39, 48, 52, 55, 58, 62,* 70

LUBES — REFINING

Solvent treating is the most widely used method of refining lubricating oils. These processes yield products that meet the requirements of a modern lubricant by removing from the charge material those undesirable constituents such as aromatics, naphthenes and unsaturates. The solvent treated lubricating oils have higher viscosity indices, greater resistance to gum and sludge formation by oxidation, and increased susceptibility to further improvement by addition of selective additives.

Most commercial processes for this operation are single solvent processes. A few mixed or double solvent processes are in use.



Typical single solvent lube treating process

Furfural Refining

A single solvent process for removing aromatic, naphthenic, olefinic, and unstable hydrocarbons from a lubricating oil charge, thereby improving its VI and stability characteristics. The solvent furfural is an aldehyde, manufactured from oat hulls.

This process is used largely on stocks from mixed-base crudes; also coastal stocks and Pennsylvania charge materials.

For mixed-based oils, treating temperatures are around 200° F (range 100-250° F). Those for Coastal oils are lower, while those for Pennsylvania stocks are somewhat higher. The treating is conducted in counter flow towers (packed or employing the Rotating Disc Contactor design) or multistage units. A high temperature gradient in the treating section permits high yield and quality of refined oil for a given solvent dosage. Furfural has high stability and can be recovered at tempera-

tures not over 450-550°F.

This process has been developed and is licensed by the Texaco Development Corp., New York. It was first commercially applied in 1933 at the Indian Refining Co., plant at Lawrenceville, Ill.

Furfural Refining references include:

(1) Brown, L. C., "Pilot Plant Aids Operation of Furfural Extraction Unit," *Oil & Gas J.*, June 14, 1947, pp. 112-4
(2) Brown, L. C., and C. F. Tears, "New Furfural Solvent Lube Plant," PETROLEUM PROCESSING, July 1947, pp. 492-96, 557
(3) Bryant, G. R., R. E. Manley, and B. Y. McCarty, "The Solvent Refining of Lubricating Oils with Furfural," *Oil & Gas J.*, April 16, 1935, p. 53
(4) Evans, W. V., and M. B. Aylesworth, "Some Critical Constants of Furfural," *Ind. & Engrg. Chem.*, Jan. 1926, pp. 24-7
(5) Kemp, L. C., Jr., G. B. Hamilton, and H. H. Gross, "Furfural As a Selective Solvent in Petroleum Refining," *Ind. & Engrg. Chem.*, Feb. 1948, pp. 220-7
(6) Livingston, M. J. and J. T. Dickinson, "Packed Towers Useful in Solvent Refining," *Nat. Pet. News*, July 1935, pp. 25-9
(7) Manley, R. E., B. Y. McCarty, and H. H. Gross, "Use Furfural as The Extraction Solvent to Make Motor Oils Have a Lower Viscosity," *Pet. Ref.*, Dec. 1933, pp. 420-31
(8) Mertens, F. T., "Refining Pennsylvania Oils with Furfural," *Oil & Gas J.*, Nov. 7, 1940, pp. 47-8
(9) Smoley, E. R., A. H. Schutte, and H. R. Davis, "Cost and Extent of Solvent Refining and Dewaxing of Lubricating Oils," *World Pet.*, Nov. 1938, pp. 76-9
(10) Weber, G. "Gulf-Treating Lubricating Stock from Various Crude Oils in New Solvent Unit," *Oil & Gas J.*, July 2, 1936, pp. 30-2
(11) Ziegenhain, W. T., "Simple, Compact and Unusually Flexible Vacuum Asphalt Unit Completed at Sunray Refinery," *Oil & Gas J.*, May 30, 1933, p. 44

Available engineering services for Furfural Refining:

PROC DESIGN: 3, *6*, *8*, *17*, 23, *25*, 38, *40*, 47, *48*, 49, *52*, 55, *56*, 58, *62*, 70, 72, 73

MECH ENGRG: 3, *6*, *8*, *11*, *17*, 23, *25*, *38*, *39*, *40*, 47, *48*, 49, 51, *52*, *56*, 58, *59*, *62*, 70, 72, 73

CONSTR: 3, *6*, *8*, *11*, *17*, 23, *25*, 28, *38*, *39*, *40*, 47, *48*, 49, *52*, 55, *56*, 58, *59*, *62*, 70, 72, 73, 76, *79*

Phenol Extraction

A single solvent, liquid-liquid extraction process for the removal of aromatic, unsaturate and naphthenic constituents of lubricating oils, thereby improving the viscosity index, oxidation stability and resistance to sludging, carbon formation and lacquer deposition. Distillate oils can also be treated. The solvent phenol is employed in either anhydrous or aqueous form.

Modern plants employ towers containing plates. Feed is preheated, passed through an absorption tower to pick up phenol from an aqueous mixture (obtained in the phenol recovery step), and is added to the treating tower for anhydrous phenol treatment.

Treating temperatures vary with the charge material. For lubricating oils the treating tower is maintained at 225-230°F at the top and 155°F at the bottom. High temperatures are desirable to treat waxy stocks.

One of the features of the process is the use of water to reduce the solubility of oil in phenol at the bottom of the tower. Water displaces the high VI constituents that may be present in the extract phase before it is removed from the system.

M. W. Kellogg Co., New York, is the licensor for this process, under the patents and patent rights of Esso Standard Oil Co., Union Oil Co. of Calif., Standard Oil Co. (Ind.) and M. W. Kellogg Co.

Phenol Extraction references include:

(1) Kalichevsky, V. A., "Estimation of Properties of Solvent-Refined Products," *Pet. Ref.*, Jan. 1947, pp. 17-22
(2) Kenny, D. W., and W. B. McCluer, "Refining Pennsylvania Lube Oils by Phenol Extraction," *Oil & Gas J.*, Jan. 16, 1941, pp. 48-9, 56
(3) Stines, D. E., "Some Recent Trends in Phenol Plant Design and Operation," *Oil & Gas J.*, Mar. 19, 1936, pp. 75-6
(4) Stratford, R. K., and Huggett, J. L., "Phenol Used in Production of High-Grade Lubricants at Port Jerome Refinery," *Oil & Gas J.*, Dec. 27, 1934, pp. 44-6
(5) Stratford, R. K., H. H. Moor, and O. S. Pokorny, "Successfully Use Phenol As Selective Solvent in Manufacturing Lubricants and Special Oils," Proceedings of the World Petroleum Congress, 1933, p. 362
(6) Stratford, R. K., O. S. Pokorny, and J. L. Huggett, "Use of Phenol as Selective Solvent in the Production of High-Grade Lubricating Oils," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, pp. 458-62

Available engineering services for Phenol Extraction:

PROC DESIGN: 3, 23, *40*, 47, *48*, *52*, 55, *58*, 60, *62*, 70

MECH ENGRG: 3, 7, 23, *39*, *40*, 47, *48*, *52*, *58*, *62*, 70

CONSTR: 3, 23, *39*, *40*, 47, *48*, *52*, 55, *58*, *62*, 70

Edeleanu SO_2 Processing

A single solvent process employed to remove sulfur and aromatics from light petroleum charges—naphtha, kerosine and other middle distillates—and to improve oxidation stability of transformer, turbine and very light lubricating oil blending stocks. However, because of its low solvent power liquid SO_2, in the absence of auxiliary solvents, is of little usefulness in the preparation of high viscosity index motor oils. Normally viscosity index above the low 50-70 level are not obtainable by use of liquid SO_2 alone. Use of liquid SO_2 (liquid SO_2—benzene) as a heavy lubricating oil-treating process will be discussed below.

Historically, the liquid SO_2—Edeleanu Process was developed in Europe for the refining of kerosine and burner oils in 1907. Its main application as a single solvent process is in the recovery of aromatics from naphtha and catalytic reformate.

Liquid SO_2 plants have been built by the Badger division of Stone and Webster Engineering Corp.

Operating temperatures range from −20°F for naphthas and kerosines to +60°F for high pour point stocks. Solvent ratios range from 0.5-3.0/1.0. The heavier charge material requiring the higher solvent/oil ratio.

Edeleanu SO_2 Process references include:

(1) Cottrell, O. P., "Edeleanu Refining Process May be Applied to Treat Practically All Petroleum Fractions," *Oil & Gas J.*, Nov. 30, 1933, p. 64
(2) Edeleanu, L., "Refining With Liquid SO_2," *Jour. of Inst. of Pet. Technology*, Dec. 1932, pp. 900-20
(3) Edeleanu, L., "News Method of Refining Petroleum by Liquid SO_2," *Nat. Pet. News*, Aug. 1926, pp. 41-3
(4) Kain, W., "Improvement in Solvent Refining of Lubricating Oils by Edeleanu Process," *Ref. & Nat. Gaso. Mfr.*, Nov. 1932, pp. 553-7
(5) *Pet. Ref.*, "Modified Edeleanu Process," Sept. 1951, pp. 237-8
(6) Plank, R., "Edeleanu SO_2 Process Used in Treating Lubricating Oils," *Nat. Pet. News*, Nov. 1928, pp. 63-71

Available engineering services for Edeleanu SO_2 Processing:

PROC DESIGN: *3*, 8, *23*, *25*, *36*, 38, *42*, 47, *48*, *52*, *55*, *58*, *62*

MECH ENGRG: *3*, 7, 8, *23*, *25*, *36*, *38*, *39*, *42*, *47*, *48*, *52*, *58*, *62*

CONSTR: *3*, 8, *23*, *25*, *36*, *38*, *39*, *42*, 47, *48*, *52*, *55*, *58*, *62*, *79*

Chlorex Extraction

A single solvent process which exhibits good selectivity and high solvent power at low extraction temperatures. Typical feed stocks are Mid-Continent stocks for VI improvement or highly paraffinic oils (derived from Pennsylvania crudes) for improved viscosity indices and increased yields from percolation filters.

Stability of chlorex obtained from the commercial product is improved by removal of the small amount of hydrochloric acid present.

Pennsylvania residual stocks contain resins but are almost free of asphaltenes. This permits refining with single solvents without deasphalting. Extraction temperatures are 100-125°F. Mid-continent distillates or deasphalted residue are extracted without wax removal at 30-80°F. High chlorex specific gravity facilitates separation of the two liquid phases.

Countercurrent multi-stage extractors (4-7 stages) or extraction towers are employed for chlorex extraction. The raffinate phase contains 15-25% solvent. Chlorex is recovered at 300-325°F at a vacuum of 26-28 in. Hg using steam.

This process was developed by the Standard Oil Co. (Ind.).

Chlorex Extraction references include:

(1) Bahlke, W. H., A. B. Brown, F. F. Diwoky, "Commercial Application of the 'Chlorex' Process in the Manufacture of High Grade Motor Oils," *Oil & Gas J.*, Oct. 26, 1933, p. 60
(2) Barton, P. D. "Modern Lubricating-Oil Plant at Marcus Hook," *Pet. Eng.*, Jan. 1944 pp. 206-18

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

(3) Page, J. M., C. C. Buchler, S. H. Diggs, "Production of Lubricating Oils by Extraction With Dichloroethyl Ether," *Ind. & Engrg. Chem.*, April, 1933, pp. 418-23
(4) Williams, D. B., "Application of the Chlorex Process to Pennsylvania Lubricating Oils," *Nat. Pet. News*, May 1935, pp. 26-32

Available engineering services for Chlorex Extraction:
PROC DESIGN: *6, 8, 13, 23, 40, 48, 58, 62*
MECH ENGRG: *6, 8, 13, 23, 39, 40, 48, 52, 58, 62*
CONSTR: *6, 8, 13, 23, 39, 40, 48, 52, 58, 62, 79*

Nitrobenzene Extraction

A single solvent process of high solvent powers applicable to lubricating oils or residua from any crude. Charge materials varying between light distillates (150SSU @ 100°F) and heavy residua (950 SSU @ 210°F) have been successfully processed. The presence of wax in the charge does not interfere with treatment, nor is deasphalting a prerequisite operation for the charge material. Clay treatment is normally employed for color and carbon residue improvement.

High solvency power of nitrobenzene enables use of low extraction temperatures (30-100°F) and low solvent-oil ratios 0.5-0.3/1.0. Refrigeration equipment may be necessary. Nitrobenzene recovery from the oil takes place at about 350°F by applying vacuum and steam.

A "cascade" countercurrent five-stage treating system is employed to contact oil with the solvent.

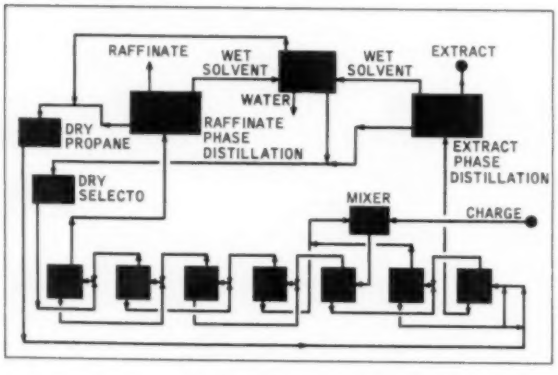
This process was developed and is commercially employed by the Atlantic Refining Co.

Nitrobenzene Extraction references include:

(1) Ferris, S. W., Jr., and W. F. Houghton, "The Nitrobenzene Process For Lubricating Oils," *Ref. & Nat. Gaso. Mfr.*, Nov. 1932, pp. 560-7, 581-3
(2) Ferris, S. W., Jr., W. A. Myers, and A. G. Peterkin, "The Nitrobenzene Process-Installation and Operating Costs," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, pp. 435-44
(3) Myers, W. A., "Superior Lubricants via the Nitrobenzene Process," *Oil & Gas J.*, Mar. 19, 1936, pp. 81-91
(4) *Pet. Ref.*, "Nitrobenzene Extraction," Sept. 1952, pp. 56-7

Available engineering services for Nitrobenzene Extraction:
PROC DESIGN: *6, 8, 13, 23, 25, 48, 52, 58, 62*
MECH ENGRG: *6, 8, 13, 23, 25, 39, 48, 52, 58, 62*
CONSTR: *6, 8, 13, 23, 25, 28, 39, 48, 52, 58, 62, 79*

Duo-Sol Extraction



A double solvent lube treating process for the simultaneous deasphalting and solvent treating of a lube or any residual or distillate base stock. Propane is employed as the paraffinic solvent for the deasphalting operation. Cresylic acid, usually containing from 20-40% phenol, is the naphthenic solvent. (Pure phenol may be used.) The cresylic acid—phenol mixture is referred to as "selecto." Due to the dilution of oil with propane, the viscosity of the raffinate phase is low and its separation from the extract phase is relatively easy. Under normal treating temperatures the solubility of wax in propane is sufficiently high to permit solvent extraction of most oils in the un-dewaxed state.

Commercial units are multistage (7-9) counterflow type. Fresh oil is introduced into the extraction system two or three stages from the exit end. Propane and selecto are introduced at the extract and raffinate outgoing stages, respectively.

Operating conditions include 120-150°F extraction temperature, although certain charge stocks have been treated at as low as 90°F. Solvent to oil ratios are 4.0/1.0 (or higher) by weight and by volume for propane and selecto, respectively. The phenol content of selecto is 35-40% by volume or higher. Water content of selecto is held below 0.15%.

The number of variables in Duo-Sol Extraction is considerable. Normally speaking the following generalities apply: (1) at constant propane to selecto ratio, an increase in total solvents to oil ratio improves viscosity index and carbon residue of the raffinate; (2) at constant selecto to oil ratio, an increase in propane lowers viscosity index and may lower or increase carbon residue; (3) at constant propane to oil ratio, an increase in selecto improves viscosity index and carbon residue.

This process was developed by Max B. Miller Co. and is licensed by the Milwhite Co., Inc.

Duo-Sol Extraction references include:

(1) Albright, J. C., "Union Oil Two-Solvent Lube Unit Operating," *Pet. Engrg.*, Feb. 1950, pp. C-11-14
(2) Barton, P. D., "Modern Lubricating-Oil Plant at Marcus Hook," *Pet. Engrg.*, Jan. 1944, pp. 206-18
(3) Cobb, M. L., "Double Solvent Extraction of Residual Stocks," *Pet. Engrg.*, May 1949, pp. C-47-56
(4) Hightower, J. V., "Refining Lubricating Oil by Solvent Extraction," *Chem. Engrg.*, April 1935, pp. 82-5
(5) Tuttle, M. H., and M. B. Miller, "Duo-Sol Process in Manufacture of Lubricating Oils," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, p. 453
(6) Tuttle, M. H., "Performance, Flexibility of the Duo-Sol Process," *Oil & Gas J.*, Jan. 7, 1935, pp. 13-14

Available engineering services for Duo-Sol Extraction:
PROC DESIGN: 8, 23, 47, *48, 52, 55, 56, 58, 62,* 70
MECH ENGRG: 8, *39,* 47, *48, 52, 56, 58, 62,* 70
CONSTR: 8, 23, *39,* 47, *48,* 52, *55, 56, 58, 62,* 70

Liquid SO_2—Benzene Process

A mixed solvent process for the treating of lubricating oils to effect viscosity index improvement (and dewaxing simultaneously, if conditions are so chosen).

Varying the percentage of benzene in the solvent mixture makes it possible to select the most advantageous treating conditions for any charge stock in order that the desired specification product can be obtained. At a given extraction temperature, an increase in the percentage of benzene increases the solvent power of the mixture.

The design of the plant is similar to that of a single solvent process but the solvent recovery system is more elaborate to permit separate recovery of the solvents.

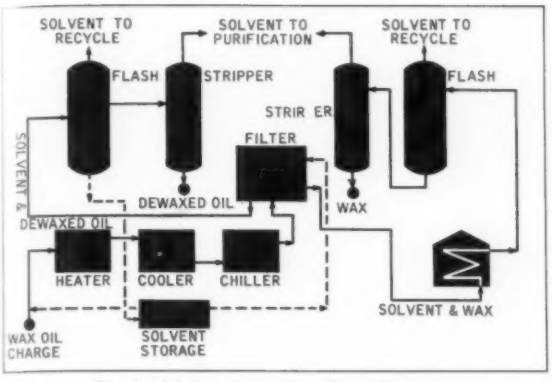
Extraction temperature is about 25°F. The mixed solvent to oil ratio is about 2.0/1.0. Finished lubricating oils have 90-100 viscosity index with improved carbon residue and oxidation stability.

Liquid SO_2-Benzene Process references include:

(1) Albright, J. C., "Process Description-Liquid SO_2-Benzene," *Nat. Pet. News*, Oct. 1935, p. 25
(2) Cottrell, O. P., "Scope and Flexibility of the Edeleanu Process," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, pp. 432-4
(3) Gard, E. W., and E. G. Ragatz, "Fundamentals of the Solvent Refining Operations as Applied to the Petroleum Industry," *Oil & Gas J.*, June 6, 1940, pp. 49-52
(4) Kain, W., "Improvement in Solvent Refining of Lubricating Oils by Edeleanu Process," *Ref. & Nat. Gaso. Mfr.*, Nov. 1932, pp. 553-7
(5) Stockman, L. P., "Liquid SO_2-Benzol Process," *Oil & Gas J.*, Aug. 16, 1934, p. 6

LUBES — DEWAXING

Processes designed to remove wax from lubricating oils in order that the product will exhibit good fluidity characteristics at low temperatures (low pour point). The mechanism of solvent dewaxing can be either the separation of wax as a solid which has been crystallized from the oil solution at low temperature, or the separation of wax as a liquid which has been extracted at temperatures above the melting point of the wax through preferential selectivity of the solvent. This latter method has not been developed to the commercial stage. The former mechanism is the basis upon which all existing commer-



Typical lube dewaxing flow diagram

cial solvent dewaxing processes of significant importance operate.

Solvents for dewaxing should: (1) have substantially complete solvent action on the wax bearing oil between 100°F and minimum chilling temperature of the oil-solvent mixture; (2) have complete solvent action on the normally liquid components present in the waxy oil, but substantially no solvent power for the wax precipitated at the minimum chilling temperature; (3) be readily available at low cost; (4) be chemically stable, noncorrosive and not highly toxic; (5) have a boiling point that permits recovery from oil and wax by distillation; (6) be unaffected and easily separated from water; and (7) have latent heat and specific heat characteristics conducive to economical refrigeration.

All the processes have the following steps in common; feed stock is contacted with solvent, mixture is chilled and precipitated wax is separated, solvent is recovered from wax and dewaxed oil for reuse. Depending upon the process type, outside or auto-refrigeration is employed; wax separation is accomplished through filtration or centrifuging.

Solvent dewaxing processes are often carried out in conjunction with wax deoiling processes. Modern solvent methods, which started to be employed in significant amounts commercially in the mid 1930's, have superseded the old methods, which included cold settling, filter pressing and centrifuging using naphtha. However, the same basic principles exist today that governed the older non-solvent processes.

Available engineering services for Solvent Dewaxing:
PROC DESIGN: 3, *6*, *8*, *11*, 23, *25*, 38, *40*, 42, 47, 49, 55, *56*, *58*, *62*, 70, *72*
MECH ENGRG: 3, *6*, 7, *8*, *11*, 23, *25*, 38, *39*, *40*, 42, 47, 49, 51, *52*, *56*, *58*, *59*, *62*, 70, 72, 74
CONSTR: 3, *6*, *8*, *11*, 23, *25*, 28, 38, *39*, *40*, 42, 47, 49, *52*, 55, *56*, *58*, *59*, *62*, 70, 72, *79*

MEK Dewaxing

This process, sometimes erroneously referred to as the benzol-acetone process, employs any single or mixed solvent, except hydrocarbon solvents having less than five carbon atoms. Mixtures of MEK and toluol are now in general use although other ketones are also used either alone or mixed with an aromatic solvent. Examples of single solvents employed by one or more licensees of the Solvent Dewaxing Process are methyl-iso-butyl-ketone and methyl-normal-butyl-ketone.

The composition of the solvent mixture depends largely upon the type of stock being dewaxed. The more paraffinic stocks are dewaxed with a solvent containing less ketone than is generally used dewaxing naphthenic or asphaltic stocks. The use of a solvent mixture of this type is an example of the dual opposing solvent dewaxing theory—both oil and wax are relatively insoluble in one solvent (MEK) while both oil and wax are soluble in all proportions in the other solvents (benzol and toluol). Hence, proper proportioning the two opposing solvent actions permits control of wax solubility.

The solvent and charge oil are mixed with a solvent-oil ratio varying between 1.0/1.0 to 4.5/1.0 depending upon the nature and viscosity of the charge. The mixture is then chilled through heat exchange and outside ammonia refrigeration to a temperature a few degrees below the desired pour point of the dewaxed oil (—12°F for cylinder stock charge). Low pressures are employed throughout the process. The chilled oil and precipitated wax are then filtered—leaf or continuous rotary vacuum. Wash solvent is used on the wax filter cake before it is removed. The solvent-oil mixture is sent to the solvent recovery system for distillation in a multiple effect evaporating unit. The solvent is removed from wax slurry mix in a single effect evaporating unit.

This process is the most widely used solvent dewaxing process in the petroleum industry today. The first commercial unit was installed in 1927. It is licensed by the Texaco Development Corp.

MEK Dewaxing references include:

(1) Chenault, W. B., "Sinclair's Solvent Dewaxing Unit," *Oil & Gas J.*, Aug. 3, 1939, p. 49
(2) Gee, W. P., W. Kiersted, and B. Y. McCarty, "Two-Solvent System Offers Advantages in Solvent Dewaxing," *Nat. Pet. News*, May 1936, pp. 29-33
(3) Gover, F. X., and G. R. Bryant, "Solvent Dewaxing of Oil With Benzene and Acetone," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, pp. 222-8
(4) Hall, F., and B. Y. McCarty, "Miscibility Relations in Solvent Dewaxing," *Nat. Pet. News*, July 14, 1937, pp. R15-25
(5) Hinman, J. M., and R. R. Maddocks, "'Reverse Sequence' Dewaxing Cuts Solvent, Refrigeration Needs," PETROLEUM PROCESSING, Nov. 1949, pp. 1215-8
(6) Mueller, A. J., "Mixture of Ketones Used to Dewax Motor Lubricants," *Oil & Gas J.*, April 18, 1940, pp. 54-6.
(7) Myers, W. A. "Atlantic Refining Co. Uses Mixture of Acetone-Benzene for Dewaxing," *Oil & Gas J.*, Mar. 18, 1935, pp. 78-80
(8) PETROLEUM PROCESSING, "First Use of Centrifugal Compressors For Plant Refrigeration," Feb. 1949, pp. 149-50
(9) Smoley, E. R., A. H. Schutte, and H. R. Davis, "Solvent Refining of Lubricating Oils," *Ref. & Nat. Gaso. Mfr.*, Nov. 1938, pp. 535-40
(10) Tiedje, J. L., and D. M. MacLeod, "Higher Ketones as Dewaxing Solvents," *Pet. Ref.*, Feb. 1955, pp. 150-4
(11) Thornton, D. P. Jr., "Pure Oil's First Solvent Lube Plant Now in Operation at Smiths Bluff," PETROLEUM PROCESSING, March 1950, pp. 245-7
(12) Weber, G., "Ketone-Benzene Dewaxing Process is Employed by Gulf at Port Arthur," *Oil & Gas J.*, July 16, 1936, pp. 46-8

Available engineering services for MEK Dewaxing:
PROC DESIGN: 3, *6*, *8*, *13*, 23, *25*, *32*, *40*, 47, *52*, *55*, *56*, *58*, *60*, *62*, 70, 75
MECH ENGRG: 3, *6*, *8*, *11*, *13*, *23*, *25*, *39*, *40*, *47*, *52*, *56*, *58*, *62*, *70*
CONSTR: 3, *6*, *8*, *11*, *13*, 23, *25*, *32*, *39*, *40*, 47, *52*, *55*, *56*, *58*, *62*, 70

Propane Dewaxing

Lube oils and lube blending stocks are dewaxed by this process. Feed stocks ranging from paraffin distillates of 70 viscosity (SUS @ 100°F) to cylinder stock of 250 viscosity (SUS @ 210°F) have yielded zero or lower pour points. Like the other solvent processes, propane can also be employed to deoil wax to an acceptable market product (Propane DeOiling Process).

Continuous rotary filters are employed for separation of the wax-oil mixture which has been chilled by auto-refrigeration. The temperature is reduced at a controlled rate to the desired filtering temperature by evaporation of the propane.

Yields of 60-85% of dewaxed oil from a deasphalted, solvent treated charge have been obtained at solvent-oil ratios of 2.5-3.0/1.0. Filtering temperatures range from —34° to —41°F. The entire process, with the exception of the chilling cycle, is continuous. Pressure in most parts of the system is 180-200 psi.

This process is simple and economical. One fluid—propane—serves as solvent, diluent, refrigerant, blanketing gas and filter blow back. In dewaxing oils of varying viscosities, the only solvent adjustment required is the ratio of propane to oil.

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

Reduction of pressure on the oil-solvent mixture results in evaporation of the solvent with attendant refrigerating effect.

This process is licensed by M. W. Kellogg Co. It is employed commercially in several large refineries in the United States and abroad.

Propane Dewaxing references include:

(1) Anderson, A. P., H. O. Forrest, and L. Van Horn, "Propane Deasphalting and Dewaxing of Mid-Continent Residuum," *Oil & Gas J.*, June 4, 1936, pp. 103-6
(2) Bahlke, W. H., R. N. Giles, and C. E. Adams, "Dewaxing Oils in Propane Solution with Self-Refrigeration," *Ref. & Nat. Gaso. Mfr.*, Dec. 1933, pp. 229-34
(3) Berne-Allen, A., Jr., and L. T. Work, "Solubility of Refined Paraffin Waxes in Petroleum Fractions," *Ind. & Engrg. Chem.*, July 1938, pp. 806-12
(4) Bray, U. B., C. E. Swift, and D. E. Carr, "Results Obtained from Use of Propane During Dewaxing and Treating Lubrication Oil," *Oil & Gas J.*, Nov. 2, 1933, pp. 14-16
(5) Brown, E. E., "Continuous Rotating Filters in Propane Dewaxing," *Oil & Gas J.*, June 4, 1937, p. 107
(6) Conine, R. C., "Pennsylvania Refiners Learn of Advantages of Propane Dewaxing," *Oil & Gas J.*, Dec. 20, 1934, pp. 17, 33
(7) Cooke, M. B., E. Petty, and P. Barton, "Continuous Deasphalting, Deresining and Dewaxing by Sun-Alco Process," *Nat. Pet. News*, April 1938, pp. R186
(8) Griswold, J., "Mechanism of Paraffin-Wax Filtration; Continuous Drum Filter Dewaxing of Cylinder Stocks in Propane Solution," *Trans., Amer. Inst. Chem. Engrs.*, 1939, pp. 505-15
(9) Lacey, W. N., and B. H. Sage, "Properties of Pure Propane," *Oil & Gas J.*, Feb. 14, 1935, pp. 49-52
(10) Moulton, R. W., and V. K. Loop, "A Study of the Composition of Petroleum Waxes From Western Crude Oils," *Pet. Ref.*, Apr. 1945, pp. 161-4

Available engineering services for Propane Dewaxing:
PROC DESIGN: 23, 40, 47, 55, 58, 60, 62
MECH ENGRG: 7, 23, 39, 40, 47, 58, 62
CONSTR: 23, 28, 39, 40, 47, 55, 58, 62

Liquid SO_2—Benzene Dewaxing

This process has been described under the section Lubes—Refining and Treating (Liquid SO_2-Benzene) from the standpoint of removing low viscosity index constituents from lubricating oil charge. The ratio of liquid SO_2 to benzene is considerably lower in dewaxing than in the lube refining process. The quantity of liquid SO_2 varies between 15 and 30% as compared to the greater than 50% volume employed in solvent refining.

As in propane dewaxing, SO_2 evaporation furnishes internal refrigeration for the precipitation of wax prior to removal via closed continuous rotary filters. This process can advantageously be employed to follow Liquid SO_2-Benzene extraction for viscosity index improvement through adjustment of the solvent composition. Deoiling of slack wax to high melting point wax can also be accomplished with proper adjustment of the necessary process flow and variables.

Liquid SO_2-Benzene Dewaxing references include:

(1) Bray, U. B., C. E. Swift, and D. E. Carr, "Results Obtained From Use of Propane During Dewaxing and Treating Lubricating Oil," *Oil & Gas J.*, Nov. 2, 1933, pp. 14-16
(2) Bray, U. B., "Solvent Treatment of California Lubricating Stocks, Particularly With SO_2, SO_2-Benzene," The Science of Petroleum, Oxford University Press, 1938, Vol. III., pp. 1893-1903
(3) Cottrell, O. P., "Edeleanu Refining Process May Be Applied to Treat Practically All Petroleum Fractions," *Oil & Gas J.*, Nov. 30, 1933, p. 64
(4) Kalichevsky, V. A., and K. A. Kobe, "Benzene-Liquid SO_2 Dewaxing Process," Petroleum Refining With Chemicals, Elsevier Publishing Co., Amsterdam, 1956
(5) *Oil & Gas J.*, "Dewaxing With Liquid Sulfur Dioxide-Benzene," Dec. 29, 1938, p. 131
(6) Stephens, M. M., O. F. Spencer, "Liquid SO_2-Benzene," Petrolum Refining Processes, The Pennsylvania State University Press, Pa., 1956

Separator-Nobel Dewaxing

This process is referred to as the S-N dewaxing process, or the trichloroethylene process. The solvent is a chlorinated hydrocarbon and process flow is essentially as described in the solvent dewaxing flow diagram. One difference, however, does exist. Most chlorinated hydrocarbons solvents have high specific gravities (greater than 1.0) and for this reason centrifuging rather than filtering methods are used for separating the wax.

In commercial practice the solvent-oil ratio ranges from 0.67-1.5/1.0. Charge and solvent are contacted at 110-120 F and the mixture is then chilled to a temperature of 5°F to 20 F below the desired pour point of the product, depending upon the properties of the charge stock. Cooling rate varies between 8-15°F/hr. The chilled solution is pumped to vapor-tight centrifuges, from which dewaxed oil is discharged (from center of centrifugal bowl) under relatively low centrifuge speeds – 8000-9000 rpm.

Trichloroethylene is removed from the oil and wax phases by distillation at about 230°F, followed by steam stripping.

This process is being used commercially by refineries of the Esso Standard Oil Co.

Separator-Nobel Dewaxing process references include:

(1) Backlund, N. O., "Dewaxing and Acid-Refining Mineral Oils," *Jour. of Inst. of Pet. Technology*, 1933, pp 1-34
(2) Jones, L. D., "De Laval Separator-Nobel Process," Science of Petroleum, Oxford University Press, London, 1938
(3) Kalichevsky, V. A., "Separator-Nobel Dewaxing Process," Modern Methods of Refining Lubricating Oils, Reinhold Publishing Corp., New York, 1938

Bari-Sol Process

This dewaxing process, like the S-N Process, employs a solvent which is heavier than either the oil to be treated or the wax to be separated. Like the S-N Process also, the heavy chlorinated solvent-wax containing hydrocarbon mixture is amenable to separation by centrifugal dewaxing operation.

The solvent employed commercially is a mixture of ethylene dichloride (78%) and benzol (22%); the composition will vary with the type of stock to be dewaxed. Benzol is required as ethylene dichloride has insufficient solvent power towards the oil constituents at the lower temperatures.

Solvent-oil ratios of about 3.0/1.0 are employed. The mixture is heated to about 110°F and then chilled by ammonia refrigeration. A chilling temperature of −8°F to −12°F has been employed in dewaxing Mid-Continent stocks to a 0°F pour point.

After centrifuging, the wax phase is diluted with further quantities of solvent (solvent-oil ratio-8.0/1.0) and recentrifuged at a lower temperature than the first operation, −15°F to −20°F. Solvent is recovered from the oil and wax phases at a temperature of 290°F. This process has been developed by the Sharples Specialty Co. and Max B. Miller and Co., Inc.

Bari-Sol Process references include:

(1) Albright, J. C., "Solvent Dewaxing Process at Ponca City Refinery," *Ref. & Nat. Gaso. Mfr.*, Mar. 1936, pp. 287-92
(2) Backlund, N. O., "Dewaxing and Acid-Refining Mineral Oils," *Jour. of Inst. of Pet. Technology*, Mar. 1933, pp. 1-24

Available engineering services for the Bari-Sol Process:
PROC DESIGN: 8, 58, 62
MECH ENGRG: 8, 39, 58, 62
CONSTR: 8, 39, 58, 62

WAXES

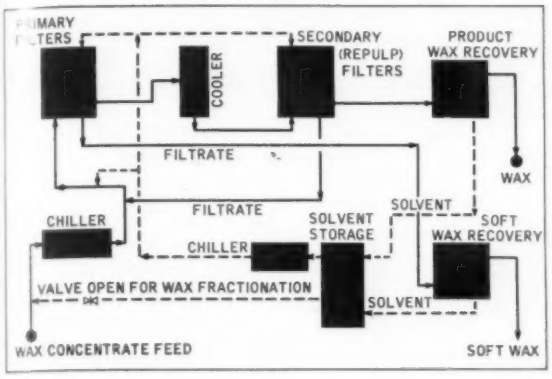
Processes employed for the production of waxes are aimed at deoiling the petroleum wax concentrate (slack wax) which is a product of the dewaxing processes.

The wax deoiling operations, which are physical in nature, are similar to those used in dewaxing oils and often vary only in the choice of treating conditions. Oil as well as low melting point waxes are separated from the waxy concentrate charge to obtain a product of desired specifications. The deoiling of wax is sometimes combined with the dewaxing of oil operation.

Slack wax may contain 10-50% oil, which is removed by sweating (not discussed herein) or by refining with solvents.

Dewaxing of residual stocks yields wax concentrates containing microcrystalline waxes (petrolatum). Deoiling is accomplished only through solvent processes to yield 140-200°F melting point products.

Solvents employed in the crystallization and production of wax are similar to those employed in the dewaxing of oils—naphtha, benzene-acetone, methyl-butyl-ketone, liquid sulfur dioxide and kerosine, liquid propane, and hexane and butyl acetate. Naphtha is usually not employed in the deoiling of microcrystalline wax.



Wax Fractionation

A physical process operated for the production of wax of low oil content. The product wax can be crystalline (paraffin) or microcrystalline with various melting points, depending upon the nature of the charge. Crystalline waxes having oil contents less than 0.5% can be produced.

A selected portion of wax from a concentrate is crystallized in the presence of a large amount of solvent, which is added to the concentrate before crystallization is commenced. The solvent-concentrate mixture is first pumped to a chiller where crystallization starts and then to a filter. The wax cake is washed with cold solvent. The cake is continuously discharged from the primary filters, mixed with additional solvent and the wax again continuously separated by means of a second filter after a final solvent wash. The discharge from the second filter is feed to the product wax and solvent recovery operation. Second stage filtrate is recirculated to the feed of the first stage filter.

Filtrate from the primary filters is charged to soft wax and solvent recovery operation. The solid wax is separated from the liquid phase (in both stages) at temperatures suitable for the desired degree of fractionation—practical range, 5-60°F.

This process is often combined with oil dewaxing with overall solvent dosages varying between 3.5-9.0/1.0 depending upon the nature of the charge material.

This process is licensed by the Texaco Development Corp., New York.

Wax Fractionation references include:

(1) David, R. A., and P. M. Huemmer, "Production of Waxes from California Crudes," *Chem. Engrg. Prog.*, Apr. 1947, pp. 174-6
(2) *Pet. Ref.*, "Wax Fractionation," Sept. 1956, p. 272
(3) Schutte, A. H., "The Emulsion Deoiling Process," *Ref. & Nat. Gaso. Mfr.*, Nov. 1940, p. 83

Available engineering services for Wax Fractionation:

PROC DESIGN: 3, *6*, *8*, *17*, 23, *25*, 38, 58, *40*, 42, 47, 49, *56*, *58*, *62*, *70*, 72
MECH ENGRG: 3, *6*, *8*, *17*, 23, *25*, *38*, *39*, *40*, 42, 47, 49, *52*, *56*, *58*, *59*, *62*, 70, 72
CONSTR: 3, *6*, *8*, *17*, 23, *25*, 28, *38*, *39*, *40*, 42, 47, 49, *52*, *56*, *58*, *59*, *62*, 70, 72, *79*

Wax Manufacturing

A physical process operated for the production of oil-free wax. Depending upon the nature of the charge concentrate, the various melting point crystalline (paraffin) products can have oil contents below 0.3-0.1%. Microcrystalline waxes of low oil content can also be produced.

The crystallization of the total wax or of a desired selected portion of the concentrate feed is affected by first cooling in the absence of solvent or in the presence of a limited and carefully controlled amount of solvent. Solvent in small increments is then added until all of the desired wax types have crystallized. Filtration is accomplished after sufficient cold solvent is added to permit separation of the liquid and solid phases.

Operation and flow of the process after the "chilling" operation is essentially the same as that for wax fractionation.

This process is licensed by the Texaco Development Corp.

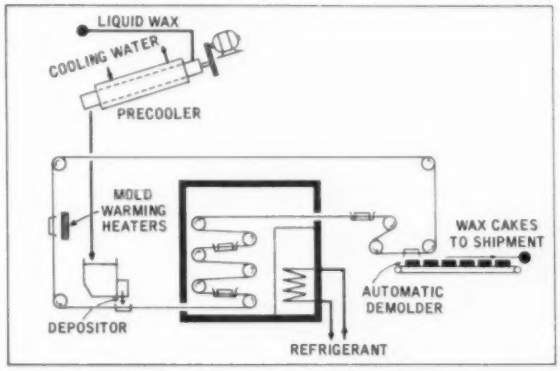
Wax Manufacturing references include:

(1) Albright, J. C., "High-Melting Paraffin Waxes," *Pet. Ref.*, July 1947, p. 121
(2) Brown, T., "Principles and Methods of Refining Paraffin Wax," *Oil & Gas J.*, Dec. 28, 1939, p. 103
(3) David, R. A., and P. M. Huemmer, "Production of High Melting Point Paraffin Waxes from California Crude Waxes," *Amer. Inst. Chem. Engrs.*, Aug. 1946, San Francisco, Calif.—reviewed in PETROLEUM PROCESSING, Oct. 1946, pp. 86-7
(4) Ebner, E. E., and F. T. Mertens, "Oil Dewaxed and Wax Deoiled in Simultaneous Operation," *Pet. Ref.*, June 1944, pp. 118-22
(5) Jenkins, V. N., "Refining of High Melting Point Waxes," *Oil & Gas J.*, Mar. 25, 1943, p. 98
(6) Thornton, D. P., Jr., "New Method of Slabbing Wax," PETROLEUM PROCESSING, Sept. 1951, pp. 963-7

Available services for Wax Manufacture:

PROC DESIGN: 3, *6*, *11*, *17*, 23, *25*, 38, *40*, 42, 47, 49, *56*, 57, *58*, *62*, 70, 72, 77
MECH ENGRG: 3, *6*, *11*, *17*, 23, *25*, *38*, *39*, *40*, 42, 47, 49, *52*, *56*, *58*, *59*, *62*, 70, 72
CONSTR: 3, *6*, *11*, *17*, 23, *25*, 28, *38*, *39*, *40*, 42, 47, 49, *52*, *56*, *58*, *59*, *62*, 70, 72, *79*

Continuous Wax Moulding



A continuous automatic materials handling operation for processing liquid wax into solid slabs of specified weight.

Microcrystalline or paraffin wax in liquid form is cooled or heated to a predetermined moulding temperature and delivered to a jacketed steel hopper, from which it is removed by piston-in-cylinder metering into mould pans. Metering is accurate to ±0.5 to 1.0 wt.% of a given stroke setting. The conveyor carries the wax through a refrigeration unit in which the residence time and amount of cooling are determined by the characteristics and quantity of the wax being processed. Solidified wax slabs are then conveyed for packaging and for shipment.

The first unit was installed at the Magnolia Petroleum Co.'s Beaumont, Texas refinery in Dec. 1950. This process is licensed by the J. W. Greer Co.

Continuous Wax Moulding references include:

(1) Kalichevsky, V. A., "Continuous Wax Moulding Lowers Cost," *Oil Forum*, Aug. 1951, pp. 288-91
(2) Keyes, B., "Continuous Molding of Petroleum Waxes," *Oil & Gas J.*, Apr. 14, 1952, pp. 128, 131, 171-2
(3) Jennings, L. H., J. H. Beard, and V. A. Kalichevsky, "Continuous Moulding of Paraffin Wax is Affected," *Pet. Ref.*, Aug. 1951, pp. 97-100
(4) Thornton, D. P., Jr., "Lube Oil Manufacture," PETROLEUM PROCESSING, May 1950, pp. 245-7

Available engineering services for Continuous Wax Moulding:

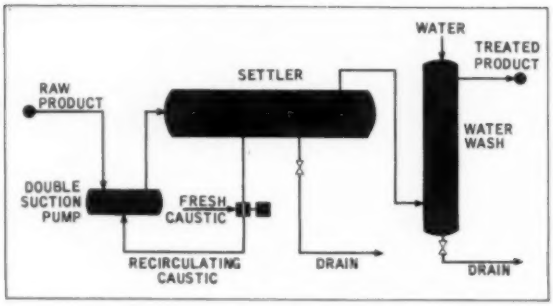
PROC DESIGN: *23*, *49*, *58*
MECH ENGRG: *23*, *39*, *49*, *52*, *58*
CONSTR: *23*, 28, *39*, *49*, *52*, *58*, 76

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

TREATING PROCESSES

CAUSTIC TREATING



Typical caustic treating flow diagram

Caustic treating of petroleum products is as old as the industry itself. Product odor and color are improved while removing organic acids and sulfur compounds (naphthenic acids, mercaptan sulfur, hydrogen sulfide, phenolic compounds). Countless equipment modifications and processes have been designed to perform the operation most effectively for specific requirements.

Stage treating, or countercurrent washing, gives more complete and effective use of reagents, and removes less reactive contaminants (i. e. mercaptans). Water washing may follow to remove carryover caustic.

Caustic solutions ranging from 5 to 20 wt-% are used at 70-110°F and 5-40 psig. Usually this closely represents run-down stream conditions. High temperatures and strong caustic are usually avoided because of the danger of color body formation and stability loss with some distillates. Caustic to product treating ratios vary from 1:1 to 1:10.

Processes incorporating caustic regeneration are popular. Very often caustic washing is used as a preliminary treatment prior to some other treating or refining process to effect savings of costly chemicals or catalyst. It may be used as a final wash in clean-up service to neutralize carry-over acids.

United States Patents for caustic treatment of oils were issued as early as 1863, and improvements have been made to the present day.

General literature references include:

(1) Borgstrom, P., "Effect of Caustic Soda on Mercaptan Sulfur in Naphtha," *Ind. & Engrg. Chem.*, Mar., 1936, p. 250
(2) Crary, R. W. and M. M. Holm, "Recovery of Mercaptans from Cracked Naphtha Fractions," *Ind. & Engr. Chem.*, Dec., 1937, pp. 1389-1395
(3) Happel, J. and D. W. Robertson, "Removal of Mercaptans from Naphtha by Caustic," *Ind. & Engr. Chem.*, Aug., 1935, pp. 941-943
(4) Henderson, L. M. et. al., "Tetraethyllead Susceptibilities of Gasoline—Doctor Treatment vs. Caustic Washing," *Ind. & Engr. Chem., Jan.*, 1939, p. 27+
(5) Kalichevsky, V. A., "Sweetening and Desulfurization of Light Petroleum Products—Part VI, Alkaline Reagents," *Pet. Ref.*, Apr., 1951, p 111+
(6) Ridgway, C. M., "Improving Gasoline by Caustic Washing," *Oil & Gas J.*, Mar. 31, 1938, p. 83 +
(7) *Ref. & Nat. Gasoline Mfr.*, "Lime Wash Used for Hydrogen Sulfide Removal," Apr., 1940, pp. 121-122
(8) *Ref. & Nat. Gasoline Mfr.*, "Propane Treating with Caustic Solution," Oct., 1940, pp. 387-388
(9) Windle, G. S., "Thiophenol in Cracked Gasoline," *Pet. Ref.*, Feb., 1944, pp. 41-45

Available engineering services for Caustic Washing:
PROC DESIGN: 1, 5, *6*, 8, *11*, *13*, 14, 15, *17*, 22, 23, 25, 29, 32, 35, 36, 38, 40, *42*, *43*, 46, 47, *48*, 52, 55, 56, 58, 59, 60, 62, 66, 70, 72, 75, 78
MECH ENGRG: *6*, 7, 8, 11, *13*, 14, 15, *17*, 22, 23, 25, 31, 35, 36, 38, *39*, 40, *42*, *43*, 46, 47, *48*, *52*, 56, 58, 59, 62, 66, 70, 72, 78
CONSTR: *6*, 8, 11, *13*, 14, 15, *17*, 22, 23, 25, 28, 29, 31, 32, 35, 36, 38, *39*, 40, *42*, *43*, 46, 47, *48*, 52, 56, 58, 59, 61, 62, 66, 70, 72, *79*

Non-Regenerative Treating

Non-regenerative caustic treating is generally economically applied when contaminating materials are in low concentration and waste disposal is not a problem.

Traces of H_2S, etc. are popularly removed from liquified gas and light gasoline streams in numerous ways with calcium, ammonium, or sodium hydroxide solutions. Common practice makes use of sodium hydroxide in a single stage system. With good contact H_2S can be reduced to less than 0.0001 wt % with accompanying partial mercaptan removal.

Cracked gasoline streams are often treated to remove phenols and mercaptans in a continuous counter-current two- or three-stage caustic scrubber system. Ring packed extraction towers with two or three caustic layers are also used. Phenols accumulating in the spent solutions facilitate extraction of mercaptans. Recovery of spent caustic solutions for sale is often a partial incentive for non-regenerative operation.

Use of non-regenerative systems is on the decline because of the waste disposal problems, and numerous other processes to effect more complete removal of contaminating materials.

Literature references include:

(1) Albright, J. C., "Mercaptan & Hydrogen Sulfide Removal by Caustic Scrubbing," *Ref. & Nat. Gasoline Mfr.*, Sept., 1938, p 437+
(2) Kalichevsky, V. A., "Sweetening and Desulfurization of Light Petroleum Products—Part VI, Alkaline Reagents," *Pet. Ref.*, Apr., 1951, p. 111+
(3) Morrell, J. C. and D. J. Bergmann, "Designing Equipment for Chemical Treatment of Oil Distillates," *Chem. & Met. Engr.*, May, 1928, pp. 291-295
(4) *Pet. Ref.*, "Mercaptans Removed Prior to Doctor Treating," Apr., 1942, pp. 103-106
(5) *Ref. & Nat. Gasoline Mfr.*, "Propane Treating with Caustic Solution," Oct., 1940, pp. 387-388
(6) Ridgway, C. M., "Improving Gasoline by Caustic Washing," *Oil & Gas J.*, Mar. 31, 1938, pp. 83-84+
(7) Sierra, A. V., "Better Caustic Utilization Within a Modern Refinery Treating Plant," *Oil & Gas J.*, Jan. 22, 1953, p. 252
(8) Walker, N. E. and E. B. Kenney, "Removing & Converting," PETROLEUM PROCESSING, Apr. 1956

Polysulfide Treating

This is a non-regenerable, chemical treating process used to remove elemental sulfur from refinery liquids.

Caustic-polysulfide solution is prepared by dissolving 1 lb of commercial sodium sulfide (50-60%) and 0.1 lb elemental sulfur to each gallon of approximately 15° Baume caustic. Sulfur is completely dissolved to avoid contamination of stock being treated. In the refinery, sodium sulfide may be prepared by bubbling hydrogen sulfide through caustic solution.

Ordinary caustic washing equipment is generally used at about 120° F for polysulfide treating. Good contacting equipment is necessary (i.e., double-suction centrifugal mixing pump). A ratio of 60% hydrocarbon and 40% polysulfide at the pump discharge yields maximum sulfur removal efficiency.

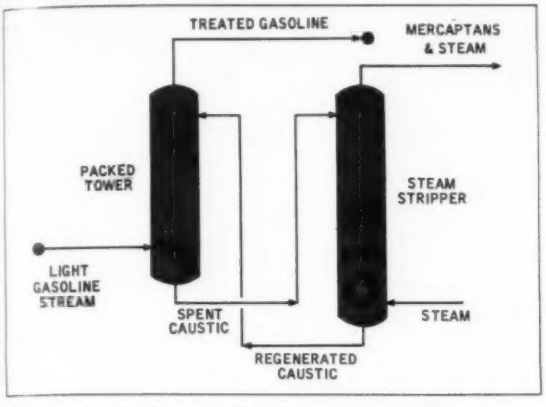
The solution is most active at a polysulfide concentration of about $Na_2S_{2.5}$. Activity decreases rapidly when concentration reaches $Na_2S_{3.5-4.0}$. When solution is discarded at least 20% of the old solution is retained and mixed with fresh caustic-sulfide solution. This eliminates the need to add free sulfur. If the hydrocarbon being treated also contains hydrogen sulfide in addition to free sulfur, it may be possible to simply add fresh caustic.

Literature references include:

(1) Broomer, G. M., "The Selection of Treating Processes for Gasoline Plants," *Pet. Ref.*, Apr. 1941, pp. 95-99
(2) Vesseloysky, V., and V. A. Kalichevsky, "Action of Alkali Hydroxides on Elementary Sulfur and Mercaptans Dissolved in Naphtha," *Ind. Engrg. Chem.*, *23*, 181-184, 1931

Available engineering services for Polysulfide Treating:
PROC DESIGN: *6*, *8*, *17*, *23*, *25*, 36, *52*, 56, *58*, *62*
MECH ENGRG: *6*, *8*, *17*, *23*, *25*, 36, *39*, *52*, 56, *58*, *62*
CONSTR: *6*, *8*, *17*, *23*, *25*, 36, *39*, *52*, 56, *58*, *62*, *79*

Regenerative Treating



Typical regenerative caustic treating

Steam-regenerative caustic treating is essentially directed toward removal of mercaptans from light straightrun gasoline.

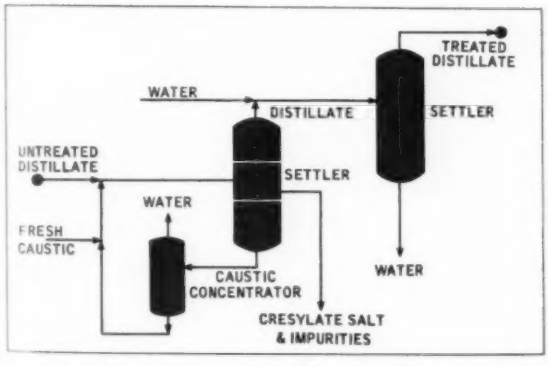
Caustic is regenerated by steam blowing in a stripping tower. The nature and concentration of the mercaptans to be removed dictate the quantity and temperature of stream.

Caustic gradually deteriorates because of the accumulation of non-extractable material. Caustic quality is maintained by continuous or intermittent discard of a minimum amount of operating solution.

Literature references include:

(1) Henderson, L. M., et. al., "Caustic Washing of Gasoline and Caustic Regeneration," *Oil & Gas J.*, Mar. 28, 1940, p. 114+
(2) Kalichevsky, V. A., "Sweetening and Desulfurization of Light Petroleum Products—Part VI, Alkaline Reagents," *Pet. Ref.*, Apr., 1951, p. 111+
(3) *Oil & Gas J.*, "Low Cost H_2S Extraction and Mercaptan Reduction," May 25, 1944, p. 80
(4) *Pet. Refiner*, "Effective Treating For a Small Plant," Apr., 1943, pp. 118-119

Dualayer Distillate Process



Developed by Magnolia Petroleum Co., this process extracts organic acidic substances (including mercaptans) from cracked or virgin distillate fuels, using Dualayer reagent. Stability, carbon residue, and storage compatibility of the distillate fuels are improved.

Reagent is continuously prepared in a settler, separating into two phases a mixture of essentially caustic (sodium or potassium hydroxide) and cresylic acid under controlled conditions. The lower phase, 43% caustic saturated with cresylate salt, is used for distillate treating. The settler also serves to separate treated distillate (top layer) and remove excess cresylate salt and impurities (middle layer) as well as continuously provide Dualayer reagent (bottom layer).

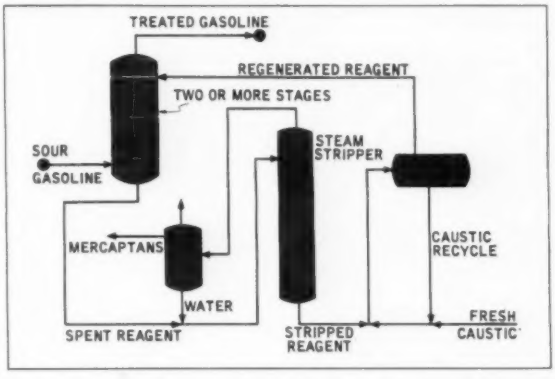
Distillate is mixed with reagent at about 130° F and passed to the settler where three layers are separated with the aid of electrical coagulation. Product is withdrawn from the top layer, water washed, and taken to storage. Dualayer reagent is withdrawn from the bottom layer, relieved of excess water of reaction, fortified with fresh caustic, and recycled.

Literature references include:

(1) Duval, C. A., et. al., "First Dualayer Treater for Fuel Oil," *Pet. Ref.*, Sept., 1955, pp. 142-144
(2) Scheumann, W. W., "Chemical and Hydrogen Treating," Petroleum Processing, Apr., 1956, p. 53-57

Available engineering services for Dualayer Distillate Treating:
PROC DESIGN: ***8, 17, 23, 25, 52, 55, 56, 58, 62***
MECH ENGRG: ***8, 17, 23, 25, 39, 52, 56, 58, 59, 62***
CONSTR: ***8, 17, 23, 25, 39, 52, 56, 58, 59, 62, 79***

Dualayer Gasoline Process



Developed and licensed by Magnolia Petroleum Co., this Dualayer process is regenerative. It is used to extract mercaptan sulfur from LPG, gasoline, and naphtha, using Dualayer reagent. Stability, odor, and TEL susceptibility of the fuels are improved.

Reagent is prepared in a settler, separating into two phases a mixture of essentially caustic and cresylic acid salt under controlled conditions. The upper phase, potassium or sodium cresylate, is used in gasoline treating.

Gasoline, free of H_2S, is contacted with Dualayer solution (2-3 vol %) at 120°F in at least two stages, water washed, and taken to storage. Treating solution is diluted with an equal volume of water and taken to a stripper where mercaptans, gasoline, and excess water are removed for subsequent separation.

Water is recycled for caustic dilution, gasoline is recycled to the contactor, and mercaptans processed for sale or disposal. Stripped treating solution is returned to the settler along with a proper amount of fresh caustic to establish the equilibrium necessary to obtain a regenerated reagent.

The process is economically operated, and requires in the order of 10 lb of steam per bbl of treated gasoline.

Literature references include:

(1) *Chem. & Eng. News*, "Two Layer Extraction of Mercaptans from Petroleum Products," Apr. 12, 1954, p. 1508
(2) Duval, G. A. and V. A. Kalichevsky, "Dualayer Gasoline Treating Process," *Pet. Ref.*, Apr., 1954, p. 161+
(3) Duval, G. A. and V. A. Kalichevsky, "Treating Gasoline by Dualayer Process," *Oil & Gas J.*, Apr. 12, 1954, p. 122+
(4) Duval, G. A. and V. A. Kalichevsky, "Twist a Problem into a Profit," Petroleum Processing, May, 1954, pp. 691-693

Available engineering services for Dualayer Gasoline Treating:
PROC DESIGN: ***6, 8, 17, 23, 25, 52, 55, 56, 58, 62***
MECH ENGRG: ***8, 17, 23, 25, 39, 52, 56, 58, 59, 62***
CONSTR: ***8, 17, 23, 25, 39, 52, 56, 58, 59, 62, 79***

Available Engineering Services

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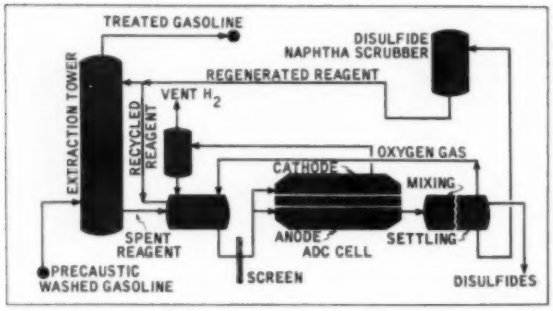


Electrolytic Mercaptan

Developed and licensed by the American Development Corp., aqueous caustic solutions (generally sodium or potassium hydroxide) are used to extract mercaptans from refinery streams. An electrolytic process is used to regenerate the solution. Disposal problems are minimized while reagent utility is maximized.

Charge stock is precaustic washed to remove H_2S and contacted countercurrently with the treating solution in a mercaptan extraction tower. The treated stream is removed to storage. Spent solution is mixed in a surge drum with some regenerated solution and by-product oxygen from the ADC cell. The mixture is screened and pumped to the ADC cell in two streams—major portion through anode sections where mercaptans are converted to disulfides and oxygen is formed—remaining portion through cathode section where hydrogen is formed (H_2 vented).

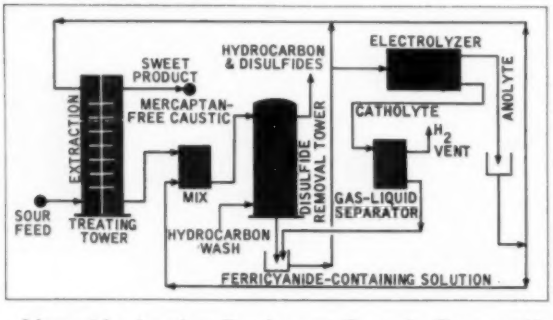
Catholyte is recycled to spent caustic and anolyte is agitated to effect additional conversion of mercaptans and then settled. Oxygen and disulfides are separated from regenerated solution which is naphtha-scrubbed for further disulfide removal. Washed solution (about 18° Baumé) is recycled to the extractors.

Literature references include:

(1) Duff, D. M., "Mercaptan Removal Ups Octane," *Oil & Gas J.*, July 19, 1954, pp. 115-117
(2) Fiske, C. E. and R. Miller, "Economics of ADC Electrolytic Mercaptan Process," *Pet. Engr.*, Nov., 1954, p. C48
(3) *Pet. Ref.*, "Gaylor Caustic Recovery Process," June, 1950, p. 119
(4) Zandona, O. J. and C. W. Rippie, "Low Cost Removal of Sulfur Compounds from Motor Fuels," *Oil & Gas J.*, June 2, 1952, p. 80+
(5) Zandona, O. J. and C. W. Rippie, "New Caustic Regeneration Process Improves Mercaptan Sulfur Removal," PETROLEUM PROCESSING, Feb., 1951, pp. 136-137

Available engineering services for ADC Electrolytic Mercaptan:
PROC DESIGN: *6, 8, 17, 23, 38, 52, 56, 58, 62, 75*
MECH ENGRG: *6, 8, 17, 23, 38, 39, 52, 56, 58, 59, 62*
CONSTR: *6, 8, 17, 23, 38, 39, 52, 56, 58, 59, 62, 79*

Ferrocyanide Process



Licensed by American Development Corp., the Ferrocyanide process is a regenerative chemical treatment for mercaptan removal from straightrun naphthas, LPG, natural and recycle gasolines, etc., using caustic-sodium ferrocyanide reagent. Sodium ferrocyanide is an additive to caustic in small concentrations, and—when converted to ferricyanide—functions as an oxidation agent in both the extraction and regeneration steps.

Gasoline is prewashed with caustic to remove H_2S and acid oils, then washed counter-currently at stream temperature in a tower with treating agent. The tower may be designed to incorporate internal mixing. It also can include extraction and sweetening sections. Operation is arranged so that gasoline contacts caustic with ferrocyanide during extraction and caustic with ferricyanide during sweetening.

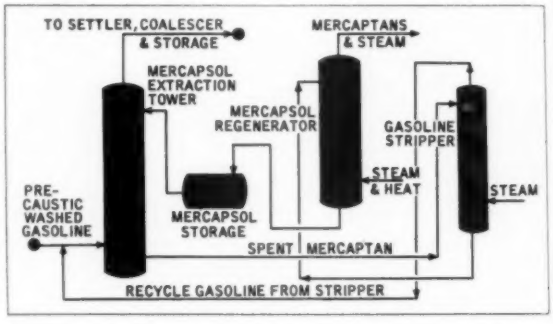
Spent solution (containing mercaptans and ferrocyanide) is mixed with fresh solution (containing ferricyanide). Mercaptans are converted to caustic insoluble disulfides and are removed by a counter-current hydrocarbon wash. Sulfur-free solution (containing ferrocyanide) is then divided into two streams, one of which returns to the extraction tower. The remaining stream is taken to an electrolyzer to convert ferrocyanide to ferricyanide. Part of the cell effluent goes to sweetening in the extraction tower and the remainder to spent-solution mercaptan-oxidation.

Literature references include:

(1) Salmon, J. H. and R. Miller, "New Process for Mercaptan Removal," *Pet. Ref.*, Sept., 1955, pp. 155-157

Available engineering services for ADC Ferrocyanide Treating:
PROC DESIGN: *6, 17, 23, 32, 56, 58, 62, 75*
MECH ENGRG: *6, 7, 17, 23, 39, 52, 56, 58, 59, 62*
CONSTR: *6, 17, 23, 32, 39, 52, 56, 58, 59, 62*

Mercapsol



Developed and licensed by Pure Oil Co., Mercapsol is a regenerative chemical treating process for extracting mercaptan sulfur (93-99%) utilizing aqueous sodium (or potassium) hydroxide containing mixed cresols as solubility promoters. Stability, odor, and TEL susceptibility are improved.

Gasoline is precaustic washed, coalesced, and contacted countercurrently with Mercapsol solution at the stream temperature. Treated gasoline is removed from the top of the tower, settled, passed through a coalescer, inhibited, and taken to storage. Spent Mercapsol solution is first settled and lightly stripped to remove gasoline, then taken to the Mercapsol regenerator where mercaptans are steam stripped from the reagent.

Pure Oil Co. installed and operated the first plant (5000 b/d) in April, 1941 at Cabin Creek, W. Va.

Literature references include:

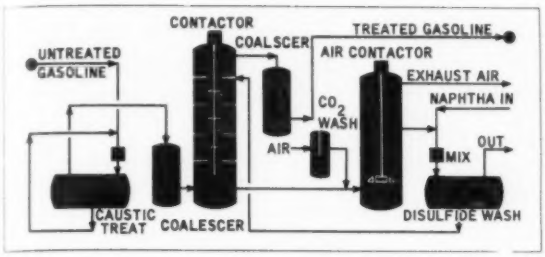
(1) Bond, D. C., "Regeneration of Caustic Solutions for Gasoline Treating by Catalytic Oxidation," *Oil & Gas J.*, Dec. 8, 1945, pp. 83-84
(2) Kalichevsky, V. A., "Sweetening and Desulfurization of Light Petroleum Products—Part VI, Alkaline Reagents," *Pet. Ref.*, Apr., 1951, p. 111+
(3) MacKusick, B. L. and H. A. Alves, "Mercapsol Process for Gasoline Treating," *Oil & Gas J.*, Apr. 13, 1944, pp. 126-127

Available engineering services for Marcapsol:
PROC DESIGN: *8, 17, 23, 25, 52, 55, 56, 58, 62*
MECH ENGRG: *8, 17, 23, 25, 39, 52, 56, 58, 62, 73*
CONSTR: *8, 17, 23, 25, 28, 39, 52, 56, 58, 62, 73, 79*

Solutizer—Air Regenerative

Developed by Shell Development Co., this process is used for mercaptan removal from heavy gasolines. It is identical to the "Solutizer—Steam Regeneration," except for the regeneration step.

Gasoline-free, spent solutizer solution is contacted with CO_2 free air in a column or turbo-aerator at about 160°F and



pressures of from 40-100 psig for 10-20 minutes. Disulfides, formed by oxidation of mercaptans, are extracted with a wash naphtha. Part of the regenerated solutizer solution is passed through a filter to remove traces of oxidation products before being recycled to the extraction tower.

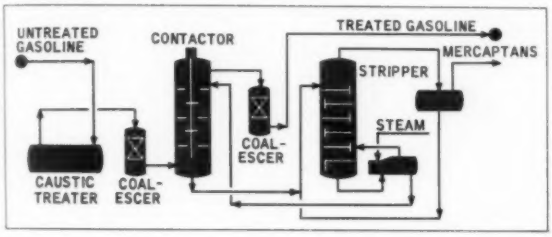
This process is being substituted for the Tannin Solutizer process because of less side reactions leading to reagent contamination. Newer units use uncatalyzed air regeneration and some old units have been converted.

Literature references include:

(1) Walker, H. E. & E. B. Kenny, "Removing and Converting Mercaptans," Petroleum Processing, Apr., 1956, pp. 58-66

Available engineering services for Air-Regeneration Solutizer:
PROC DESIGN: 5, 6, 8, 17, 23, 25, 36, 38, 47, 48, 52, 56, 58, 62
MECH ENGRG: 6, 8, 17, 23, 25, 36, 38, 39, 47, 48, 52, 56, 58, 59, 62
CONSTR: 6, 8, 17, 23, 25, 28, 36, 38, 39, 47, 48, 52, 56, 58, 59, 62, 79

Solutizer—Steam Regenerative



Developed and licensed by Shell Development Co., this is a chemical treating process for mercaptan extraction of gasoline or naphtha to odor sweet specification using "solutizers" (potassium isobutyrate, potassium alkyl phenolate, etc.) in strong potassium hydroxide solution.

The raw stream is pre-washed with caustic, then relieved of mercaptans by extraction with solutizer solution at 100° F. The ratio of solution to gasoline is 0.1-0.2. Entrained and dissolved gasoline is separated from mercaptan rich solutizer solution after dilution with regenerator condensate.

Regeneration is then effected by heating and steam blowing at 270° F in a stripping column. Steam and mercaptans are condensed and separated. Regenerated solutizer solution then returns to the extraction operation. Steam consumption is 10-30 lb/bbl gasoline treated.

The product is essentially free of TEL antagonistic mercaptans and thereby effects savings when blended to octane specifications.

The process was originally developed in 1939 by the Shell Development Co. with the first plant (15,000 b/d) being placed in operation at Shell Oil Co.'s Wood River, Ill., refinery May 17, 1940.

Literature references include:

(1) Border, L. E., "Shell Operating First Solutizer Treating Plant at Wood River," *Oil & Gas J.*, Nov. 7, 1940, pp. 55-56
(2) Border, L. E., "Solutizer, A New Principle Applied to Gasoline Sweetening," *Chem. & Met. Engrg.*, Nov., 1940, p. 776
(3) Border, L. E., "Solutizer Process for Sweetening Gasolines," *Oil & Gas J.*, July 18, 1940, pp. 36-38
(4) La Croix, H. N., "Solutizers Improve Treating of Four Types of Gasoline," *Nat. Pet. News*, Mar. 5, 1941, p. R72-80
(5) Walker, H. E. and E. B. Kenny, "Removing and Converting Mercaptans," Petroleum Processing, Apr., 1956, pp. 58-66
(6) Yabroff, D. L., "Action of Solutizers in Mercaptan Extraction," *Ind. & Engrg. Chem.*, July, 1940, pp. 950-953
(7) Yabroff, D. L., "Extraction of Mercaptans with Alkaline Solutions," *Ind. & Engrg. Chem.*, Feb., 1940, pp. 257-262
(8) Yabroff, D. L., et al, "Solutizer Sweetening," *Oil & Gas J.*, Dec. 19, 1940, pp. 35-36

Available engineering services for Steam-Regeneration Solutizer:
PROC DESIGN: 5, 6, 8, 17, 23, 25, 36, 42, 47, 48, 52, 56, 58, 62, 64
MECH ENGRG: 6, 8, 17, 23, 25, 36, 39, 42, 47, 48, 52, 56, 58, 59, 62
CONSTR: 6, 8, 17, 23, 25, 36, 39, 42, 47, 48, 52, 58, 59, 62, 79

Solutizer—Tannin

An early variation of the "Solutizer—Air Regenerative," for extracting mercaptans from gasoline using a tannin-catalyzed oxidation regeneration step, the process was jointly developed by the Socony Mobil Oil Co., Inc. and Shell Development Co. Shell's solutizer and Socony's tannin-catalyzed air regeneration techniques were combined.

Treating solution from the extraction step is heated to 110-130° F and taken to a regenerating column. Air blowing, in the presence of tannin, catalytically oxidizes mercaptans to corresponding disulfides. Presence of tannin in the solutizer reagent also aids in converting some mercaptans in the gasoline to disulfides.

New units eliminate tannin annd use higher regeneration temperatures, thus reducing undesirable side reactions and lowering chemical costs.

Literature references include:

(1) Happel, J. and S. P. Cauley, "Tannins and Allied Chemicals in Mercaptan Removal Process," *Ind. & Engrg. Chem.*, Dec., 1947, pp. 1655-1659
(2) La Croix, H. N., "Improved Refining of Sour Crudes by New Tannin Solutizer Process," *Oil & Gas J.*, Feb. 10, 1944, p. 50
(3) O'Donnell, J. P., "Tannin Solutizer Process Practically Automatic; Saves 6.5 cents per barrel," *Oil & Gas J.*, July 1, 1944, pp. 45-47
(4) Petroleum Precessing, "New Solutizer Unit has Unique Features for Disulfide Removal and Regeneration," Dec., 1947, pp. 965-966
(5) Petroleum Processing, "Tannin Solutizer Process Continues to Show Possibilities," Sept., 1946, pp.7-8
(6) Petroleum Processing, "Use of Tannins as Oxidation Catalysts in Regenerating Treating Solutions," Oct., 1946, pp. 146-147
(7) Tuttle, R. B., "Cities Service Tannin Solutizer Unit," *Oil & Gas J.*, Sept. 13, 1947, pp. 84-85
(8) Walker, N. E. and E. B. Kenney, "Removing and Converting Mercaptans," Petroleum Processing, Apr., 1956, pp. 58-66

Available engineering services for Tannin Solutizer:
PROC DESIGN: 5, 8, 17, 23, 25, 36, 38, 42, 47, 48, 49, 52, 56, 58, 62, 70
MECH ENGRG: 8, 17, 23, 25, 36, 38, 39, 42, 47, 48, 49, 52, 56, 58, 59, 62, 70
CONSTR: 8, 17, 23, 25, 28, 36, 38, 39, 42, 47, 48, 49, 52, 56, 58, 59, 62, 70, 79

Unisol Mercaptan Extraction

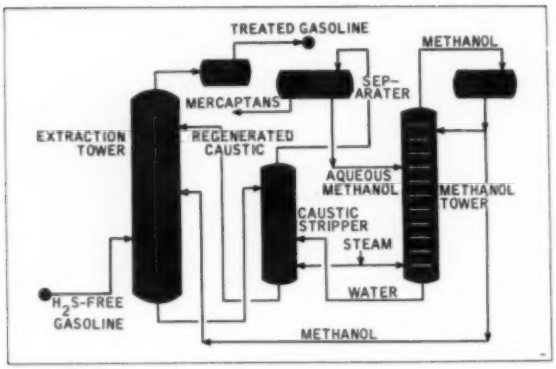
Developed by Atlantic Refining Co. and licensed by Universal Oil Products Co., Unisol is a regenerative chemical process for extracting mercaptan sulfur and certain nitrogen compounds from sour gasolines or distillates. Sodium or potassium hydroxide solutions containing methanol are used. Almost complete (99%+) mercaptan removal is effected from gasoline, accompanied by improved TEL susceptibility and stability. Distillates (heating oil, etc.) are improved in odor and stability, with 95%+ mercaptan removal.

Gasoline, free of H_2S, is contacted countercurrently with aqueous-caustic-methanol solution at about 100° F. Caustic enters the top of the extraction tower, while methanol is injected at the center. Upon leaving the tower, gasoline is settled, inhibited, and taken to storage.

Spent caustic is regenerated in a stripping tower (290-300° F) where methanol, water, and mercaptans are removed. Mercaptans are separated from methanol which is then fractionated

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.



to about 95% purity before being recycled. Caustic strength varies from 45° Baumé (regenerated) to 50° Baumé (fresh).

The process was developed by Atlantic on a pilot plant basis in 1941 at Philadelphia, Pa. One of the first commercial units was installed at the Big West Oil Co. at Kevin, Mont., and operation started in the fall of 1942.

Literature references include:

(1) Bent, R. D. and J. H. McCullough, "Atlantic Refining Company's First Year With Unisol Process," *Oil & Gas J.*, Sept. 9, 1948, p. 95
(2) Brandt, P. L. and J. O. Hougen, "Treat Cracked Distillates with Caustic Methanol Solution," *Oil & Gas J.*, Mar. 30, 1939, pp. 98-103
(3) Brown, H. A. and J. R. Strong, "Frontier Refining Company Installs Unisol Treating Plant at Cheyenne," *Oil & Gas J.*, Mar. 24, 1949, pp. 236-237
(4) Field, H. W., "Malodorus Mercaptans—Caustic Methanol Process," *Oil & Gas J.*, Sept. 25, 1941, pp. 40-41
(5) Lowry, C. D. and F. C. Moriarty, "Unisol Process Improves Octane Number and TEL Susceptibility," *Oil & Gas J.*, Nov. 3, 1945, pp. 105-106
(6) Lyles, H. R., "Better Gasoline Treating," PETROLEUM PROCESSING, May, 1955, pp. 655-657
(7) Mason, C. F., et. al., "Caustic Methanol Process," *Oil & Gas J.*, Nov. 6, 1941, p. 116

Available engineering services for Unisol Mercaptan Extraction:

PROC DESIGN: *3, 6,* 8, 22, *23, 25,* 29, *40, 48, 49,* 56, *58, 62, 72,* 78
MECH ENGRG: *3, 6,* 8, *17,* 22, *23, 25, 39, 40, 48, 49, 56, 58,* 59, *62, 66, 70, 72, 73,* 78
CONSTR: *3, 6,* 8, *17,* 22, *23, 25,* 28, 29, *39, 40, 48, 49, 56, 58,* 59, *62, 66,* 70, 72, *73, 79*

ACID TREATING

Sulfuric Acid Treating

A continuous or batch chemical treating process, it is used to remove sulfur, precipitate asphaltic material, and improve stability, color and odor of a wide variety of refinery stocks.

A standard method of treating pressure distillate for many years was acid treatment, then distillation with steam, followed by doctor sweetening.

Acid strength varies from over 100 (fuming) to 80%, with 93% being common. The weakest suitable acid is used for each particular treating situation, to reduce sludge losses due to chemical action upon aromatic and/or olefinic hydrocarbons. Temperature is kept low with strong acid (25-50° F) but higher temperatures (70-130° F) may be economical if material is to be rerun. In continuous systems contact time may be as little as one minute or, in batch treating of some kerosenes, as high as 40 minutes.

Disadvantages of the process are cost, high processing losses, and the necessity for redistillation in many cases. Present application is in the field of kerosene and special solvents.

Sulfuric acid has been used since the early days of the industry, but has been replaced to a large degree by regenerative caustic washing employing promoters and, more recently, hydrogenation.

Literature references include:

(1) Albright, J. C., "Treating Cracked Gasoline Containing Sulfur," *Pet. Engr.*, May 1937, 108
(2) Altshuler, J. A. et al, "Advantages of Stratcold Process Demonstrated Commercially," *Ref. & Nat. Gasoline Mfr.*, Apr. 193?, 181+
(3) Mapstone, G. E., "Chemistry of Acid Treatment of Gasoline," *Pet. Ref.*, Nov. 1950, 142-150
(4) Nelson, W. L., "Finishing Pressure Still Distillate into Gasoline," *Ref. & Nat. Gasoline Mfr.*, July 1936, 247-250
(5) *Oil & Gas J.*, "Sulfuric Acid for Removing the Different Forms of Sulfur," Nov. 10, 1938, p. 45
(6) Sager, F., "Modern Commercial Acid Treating Reproduced in Laboratory," *Ref. & Nat. Gasoline Mfr.*, Feb. 1938, pp. 57-61
(7) Scheumann, W. W., "Chemical & Hydrogen Treating," PETROLEUM PROCESSING, Apr. 1956, pp. 53-57
(8) Walton, J. S., "Continuous Acid Treatment of Cracked Distillates," *Ref. & Nat. Gasoline Mfr.*, Mar. 1936, pp. 94-97, and Apr. 1936, pp. 160-163
(9) Wood, A. E. et al, "Action of Petroleum Refining Agents on Naphtha," *Ind. & Engrg. Chem.*, Feb. 1926, pp. 169-171

Available engineering services for Sulfuric Acid Treating:

PROC DESIGN: 3 5, *6,* 8, 13, 14, *17,* 23, *25, 29,* 32, 35, *36,* 38, 40, 43, 46, 47, *48,* 49, *52,* 55, 56, *58, 60,* 62, 70, 71, *72,* 75, 78
MECH ENGRG: 3, *6,* 7, 8, 13, 14, *17,* 22, 23, *25,* 35, *36,* 38, *39,* 40, 43, 46, 47, *48,* 49, *52,* 56, *58, 59,* 60, 62, 70, 71, *72,* 78
CONSTR: 3, *6,* 8, 13, 14, *17,* 22, 23, *25,* 28, *29,* 32, 35, *36,* 38, *39,* 40, 43, 46, 47, *48,* 49, *52,* 55, 56, *58, 59,* 60, 61, 62, 70, *72, 79*

CLAY TREATING

Natural clay adsorbents and synthetic adsorbents are used on refinery products to improve color and odor; to eliminate water, suspended impurities, resinous or asphaltic substances, nitrogen compounds, oxygenated compounds, and some sulfur compounds; and to adsorb preferentially some hydrocarbons (olefins).

In general, three approaches have been taken to clay treating: percolation through coarse clay (lube oils, waxes, specialties); contact with powered clay (light and heavy distillates); and vapor phase contact through a loosely packed bed (gasoline and light distillates).

Percolation filters are 15-30 ft high, and may hold up to 100 tons of clay. Oil is either gravitated or pumped through the bed. Spent clay is washed with solvent and steamed in situ, then removed and regenerated by burning.

The contact process mixes finely divided clay with the refinery stream, then separates them by filtration. Regeneration is not practical. Any type refinery fraction may be treated by this process.

Vapor-phase clay treating is used for light petroleum fractions. The stream is passed through a loose clay bed slightly above the vaporization point of the fraction. Reactive olefinic material is polymerized and adsorbed as gum.

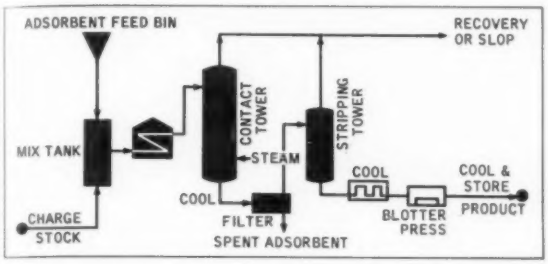
Clay treating was widely accepted in the 1930's and early '40's. Since then, however, advances in treating methods, gum inhibitors, and cracking technology have all contributed to the decline of clay treating of gasoline and distillates. Adsorbent clays are still used to improve color of lubes, but solvent extraction processes are now standard practice. Clay is frequently used as a polishing process after solvent extraction.

Literature references include:

(1) Chenault, W. B., and A. E. Miller, "New Lubricating-Oil Decolorizing and Clay Reactivating Process," *Ref. & Nat. Gaso. Mfr.*, Nov. 1941, p. 79
(2) Cooke, M. B. & A. W. Hayford, "Distillate Treating Now Highly Developed and Simplified," *Ref. & Nat. Gaso. Mfr.*, Mar. 1934, pp. 84-87, 115-122
(3) Davis, L. L., "Underlying Principles of Contact Filtration," *Ref. & Nat. Gaso. Mfr.*, Mar. 1928, p. 90+
(4) Funsten, S. R., "Percolation Filtration Process Development," *Ref. & Nat. Gaso. Mfr.*, June 1934, p. 201
(5) Funsten, S. R., "Recent Developments in the Use of Contact Clays," *Ref. & Nat. Gaso. Mfr.*, June 1937, pp. 237-249
(6) Holland, W. W., "Osterstrom Vapor Phase Treating System," *Ref. & Nat. Gaso. Mfr.*, Jan. 1932, pp. 26-27
(7) Johnson, W. A., "Decolorization of Petroleum Waxes by Adsorbent Percolation," PETROLEUM PROCESSING, Sept. 1947, p. 673
(8) Kalichevsky, V. A. & J. W. Ramsey, "Lubricating Oils in Contact with Clays," *Ind. & Engrg. Chem.*, Aug. 1933, pp. 941-943
(9) Kauffman, H. L., "Effect of Size and Shape of Filter on Percolation Filtration," *Ref. & Nat. Gaso. Mfr.*, Apr. 1928, pp. 74-78
(10) Myers, H. C. & R. M. Owen, "Economic Survey of Thermofor Installations in Socony-Vacuum Lubricating Oil Refineries," *Oil & Gas J.*, Aug. 4, 1945, p. 93
(11) Nelson, W. L., "Finishing Pressure Still Distillate into Gasoline," *Ref. & Nat. Gaso. Mfr.*, July 1936, pp. 247-250

(2) Ridgway, C. M. et al., "Study of Recovery of Oil from Spent Percolation Filters," *Oil & Gas J.*, Nov. 18, 1938, p. 154
(3) Simpson, T. P. & J. W. Payne, "Thermofor Kiln & Clay Regeneration Processes for Maintaining Decolorizing Clays at High Efficiencies," *Oil & Gas J.*, Nov. 17, 1939, p. 147+
(4) Smoley, E. R. & D. Fulton, "Modern Manufacture of Lubricating Oils," PETROLEUM PROCESSING, Aug. 1947, p. 594+

Continuous Contact Filtration



Developed by the Filtrol Corp., this is a continuous clay treating process to finish lubricants, waxes or special oils after acid treating, solvent extraction, or distillation.

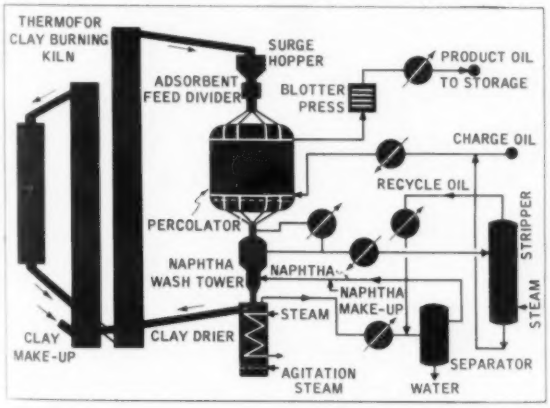
Finely divided adsorbent is mixed with the charge stock and heated to 200-350° F. Slurry is fed to a steam stripping tower. Following withdrawal from the tower, the slurry is cooled and vacuum filtered, then vacuum stripped for additional product control (flash, odor, etc.). Oil is then cooled, blotter pressed, and taken to storage. Yields normally are over 98% of the charge material.

Literature references include:

(1) Davidson, R. C., "Contact Filtration," *Oil & Gas J.*, Mar. 25, 1943, pp. 116-128
(2) Moore, M. M. & H. M. Gwyn, Jr., "Filtrol Fractionation Plant," *Ref. & Nat. Gaso. Mfr.*, Feb. 1939, pp. 45-48

Available engineering services for Continuous Contact Filtration:
PROC DESIGN: 3, *8*, *17*, 23, 36, 47, *48*, 49, 52, 56, *58*, *62*, 70, 72
MECH ENGRG: 3, 7, *8*, *17*, 23, 36, *39*, 47, *48*, 49, 52, 56, *58*, *59*, *62*, 70, 72
CONSTR: 3, *8*, *17*, 23, 28, 36, *39*, 47, *48*, 49, 52, 56, *58*, *59*, *62*, 70, 72

Thermofor Continuous Percolation (TCP)



Developed and licensed by Socony Mobil Oil Co., Inc., this is a continuous, regenerative, clay treating process to stabilize and decolorize lubricants or waxes that have been distilled, solvent refined, or acid treated.

Charge stock is heated (125-350° F) and evenly charged into the bottom of a clay packed tower by means of a multi-nozzle distributor. After passage through the clay bed, stock is passed through a blotter press and taken to storage.

Spent clay is withdrawn continuously from the bottom of the tower, or percolator, and regenerated clay is added to the top of the bed to maintain a constant level. A multi-pipe draw-off and feed-leg system insures even clay distribution and passage down the percolator. Clay feed-rate may be set to control product color.

Spent clay flows countercurrent to a wash naphtha, is dried, and regenerated in a thermofor clay burning kiln.

Wash naphtha is separated from oil in a steam stripper and returned to the wash system. Oil is recycled to the charge stock.

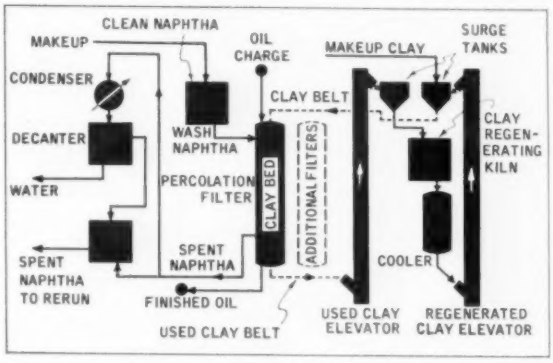
The first TCP unit (2100 b/d) was installed 1953 at the Vacuum Oil Company, Ltd. refinery at Coryton, England.

Literature references include:

(1) Evans, L. P. et al., "Thermofor Continuous Percolation," *Oil & Gas J.*, June 8, 1953, pp. 116-120
(2) Myers, H. C. & R. M. Owen, "Economic Survey of Thermofor Installations in Socony-Vacuum Lubricating Oil Refineries," *Oil & Gas J.*, Aug. 4, 1945, pp. 93-97
(3) PETROLEUM PROCESSING, "Lube Oil Improvement by Thermofor Continuous Percolation," PDS No. 8, July 1956, pp. 137-9

Available engineering services for Thermofor Continuous Percolation:
PROC DESIGN: *6*, *8*, *17*, *23*, *25*, 38, *40*, *47*, *48*, *52*, *56*, *58*, *62*, 70, 72
MECH ENGRG: *6*, 7, *8*, *17*, *23*, *25*, *38*, *39*, *40*, *47*, *48*, *52*, *56*, *58*, *59*, *62*, *66*, 70, 72
CONSTR: *6*, *8*, *17*, *23*, *25*, 28, *38*, *39*, *40*, *47*, *48*, *52*, *56*, *58*, *59*, *62*, *66*, 70, 72, *79*

Percolation Filtration



Developed by the Mineral & Chemicals Corp., this is a continuous, regenerative, liquid-phase, clay treating process to improve color, odor and stability of lube oil and waxes.

Oil is filtered through a bed containing 10-50 tons of fuller's earth or activated bauxite (20/60 or 30/60 mesh) and taken to storage. Two or more beds are used alternately on an operating and regenerating cycle.

Spent clay is washed free of oil with naphtha, then steamed to remove naphtha. Rerunning separates the oil-naphtha mix for recycle. After steaming, clay is carried to a kiln and carbonaceous material is removed by burning.

Literature references include:

(1) *Pet. Ref.* "Percolation Filtration," Sept. 1956, p. 272

Available engineering services for Percolation Filtration:
PROC DESIGN: *8*, 23, *47*, *48*, *49*, *52*, *56*, *58*, *62*, 72
MECH ENGRG: 7, *8*, 23, *39*, *47*, *48*, *49*, *52*, *56*, *58*, *59*, *62*, 72
CONSTR: *8*, 23, 28, *39*, *47*, *48*, *49*, *52*, *56*, *58*, *59*, *62*, 72, *79*

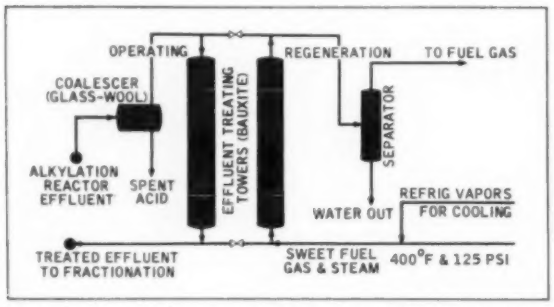
Alkylation Effluent Treating

Jointly developed by D-X Sunray Oil Co. and M. W. Kellogg Co., this is a continuous, regenerative, liquid-percolation process to remove 99% of acidic and neutral esters and carry-over acid from sulfuric acid alkylation effluent.

Reactor effluent is coalesced through glass wool and steel

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.



mesh, then charged alternately through two bauxite (medium mesh) towers. Bauxite adsorbs impurities preferentially. After contact amounts to about ¼ bbl/lb adsorbent, percolators are switched and regeneration is effected with a mixture of steam and gas. Ultimate catalyst life is about 150 bbl/lb.

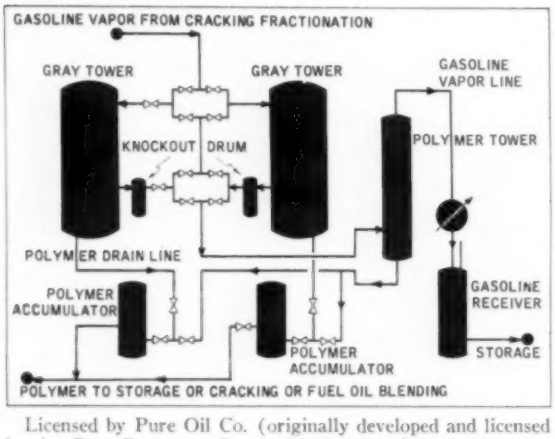
The process is claimed to be much more effective than conventional caustic washing, but with comparable capital costs.

Literature references include:

(1) *Oil & Gas J.*, "Alkylation Effluent Treating," Mar. 19, 1956, p. 180

Available engineering services for Alkylation Effluent Treating:
PROC DESIGN: 33, *56, 58, 62*
MECH ENGRG: *8, 39, 56, 58, 62*
CONSTR: *8, 28, 39, 56, 58, 62*

Gray Clay Treating



Licensed by Pure Oil Co. (originally developed and licensed by the Gray Processes Corp.) this is a continuous, regenerative (or non-regenerative), vapor phase clay treating process to selectively polymerize unsaturated gum forming constituents (diolefins) found in thermal gasolines.

For continuous operation two or more towers (10 ft diameter and up to 30 ft high) are used in parallel. Exhausted fuller's earth (30/60 mesh) is either discarded or regenerated in outside kilns.

Hydrocarbon vapors are passed through the bed at temperatures (250-475° F) slightly above the condensation point. Contact time is 20-400 seconds. Diolefins polymerize and drain from the base of the towers to polymer accumulators. Remaining polymers are separated from gasoline by a fractionating step before the product is condensed and taken to storage.

Hydrocarbon vapors go directly to Gray towers from cracking units after removal of non-condensable gases.

Gray Clay Treating (8 ton tower) was first installed commercially for motor fuel treating in the fall of 1924 at the Barnsdall Refining Co. at Barnsdall, Okla. The process was widely accepted in the 1930s and '40s. Since its utility was tied closely with thermal processing, Gray Clay Treating has gradually been discarded.

Literature references include:

(1) Albright, J. C., "12,000 Barrels Through One Ton of Clay," *Ref. & Nat. Gaso. Mfr.*, May 1931, pp. 71-73
(2) Cobb, A. W. & L. Carlson, "Pilot Plant Study of the Gray Clay Treating Process" *Oil & Gas J.*, Nov. 19, 1942, pp. 33-36
(3) Goode, R. E., "Clay Volume and Vapor Velocity Govern Color and Gums," *Ref. & Nat. Gaso. Mfr.*, Dec. 1931, p. 79
(4) Gray, T. T. & M. R. Mandelbaum, "Catalytic Treatment of Cracked Distillates in the Vapor Phase," *Ind. & Engrg. Chem.*, Sept. 1925, pp. 913-916
(5) Mandelbaum, M. R., and P. F. Swanson, "Clay Treating of Motor Fuel," *Oil & Gas J.*, May 14, 1936, p. 226+
(6) Morrell, J. C., and Gustav Egloff, "Chemical Processes in Refining of Petroleum Distillates," *Oil & Gas J.*, Mar. 26, 1936, p. 57+
(7) Price, R. H. & P. L. Brandt, "Pan American Treats Over Million Barrels Gasoline with Same Earth," *Oil & Gas J.*, Mar. 29, 1935, pp. 54-58

Available engineering services for Gray Clay Treating:
PROC DESIGN: *6, 8, 11, 17,* 23, *25,* 36, 38, *40, 48, 52, 58,* 62, *70,* 78
MECH ENGRG: *6, 7, 8, 11, 17,* 23, *25,* 36, 38, *39, 40, 48,* 49, 51, *52, 58, 59,* 62, *70,* 78
CONSTR: *6, 8, 11, 17, 23, 25,* 36, 38, *39, 40, 48,* 49, *52, 58, 59, 62, 70, 79*

OXIDATION SWEETENING

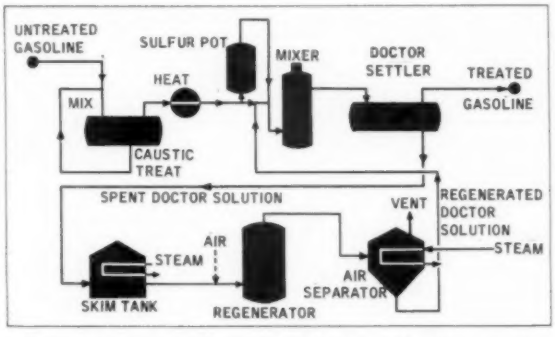
A group of processes designed to convert odoriferous alkyl mercaptans to less objectionable disulfides by oxidation. Choice of a process depends upon the particular refining situation.

A general equation may be stated as follows:

$$4RSH + O_2 = 2RSSR + 2H_2O$$

Because disulfides reduce TEL susceptibility of gasoline streams, these processes gradually are being abandoned. Recent trends are to processes which completely remove mercaptans.

Doctor Sweetening



This process, sometimes called Sodium Plumbite treating, is a continuous or batch chemical treating process to convert mercaptans in sour refinery stock to disulfides utilizing sodium plumbite solution and elementary sulfur.

Reagent is prepared by dissolving litharge (lead oxide) in 5-20 wt % sodium hydroxide solution. Amount of litharge, (1-3%) in solution depends upon temperature and caustic strength.

In continuous treating, sour stock is pre-caustic washed to remove H_2S and other acidic components. A slip stream picks up an exact amount of sulfur and rejoins the main stream which is then intimately mixed with regenerated doctor solution at 85-120° F. The mixture is settled and gasoline is taken to storage. Spent reagent is heated and skimmed in a settler, and air blown at 150-175° F to accomplish regeneration. Fresh reagent must be added periodically.

Doctor treating is still practiced even though it is one of the oldest sweetening process in the refining industry. Recent advances in hydrogen treating have reduced the need for doctor treating of distillates. Gasoline treating trends are away from doctor treating because of the deleterious effects of disulfides on the octane of leaded fuels.

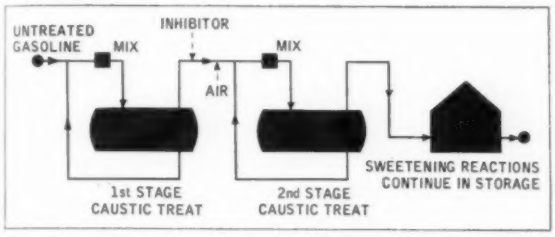
Literature references include:

(1) Berger, C. W., "Economics of Doctor Treating," *Ref. & Nat. Gaso. Mfr.*, July 1936, pp. 255-259
(2) Berger, C. W., "Naphtha & Lead Recovery System Proves Economical," *Oil & Gas J.*, Mar. 11, 1937, pp. 81-82
(3) Blair, C. M. Jr., "Selection and Application of Break-Inducing Reagents in Doctor Treating," *Pet. Ref.*, Aug. 1946, p. 379

(4) Bottomly, H., "Economics in Hypochlorite Treating," *Ref. & Nat. Gaso. Mfr.*, Sept. 1936, pp. 359-362
(5) Ellis, E. W., "Determination of Lead in Doctor Solution," *Ref. & Nat. Gaso. Mfr.*, Aug. 1936, pp. 335-336
(6) Harwick, C. D., "Use of Oxygen in Gasoline Treating," *Oil & Gas J.*, Sept. 1, 1949, p. 62+
(7) Henderson, L. M., et al, "Tetraethyllead Susceptibilities of Gasoline—Doctor Treatment vs. Caustic Washing," *Ind. Engrg. Chem.*, Jan. 1939, p. 27+
(8) Kalichevsky, V. A., "Sweetening & Desulfurization of Light Petroleum Products—Part III, Sodium Plumbite Treatment," *Pet. Ref.* Jan. 1951, p. 129+
(9) Lachman, A., "Chemistry of the Doctor Sweetening Process," *Ind. & Engrg. Chem.*, Apr. 1931, pp. 354-357
(10) Lowry, C. D. Jr., et al, "Factors in Doctor Sweetening," *Ind. & Engrg. Chem.*, Nov. 1938, pp. 1275-1279

Engineering services available for Doctor Sweetening:
PROC DESIGN: 1, 3, 8, *11*, 13, *17*, 22, 23, 25, 32, 35, 36, *38*, *40*, 46, 47, *48*, 49, 52, 55, 56, *58*, 60, 62, 70, 72, *75*, 78
MECH ENGRG: 3, 7, 8, *11*, 13, *17*, 22, 23, 25, 35, 36, *38*, 39, *40*, 46, 47, *48*, 49, 52, 56, *58*, *59*, 62, 70, 72, 78
CONSTR: 3, 8, *11*, 13, *17*, 22, 23, 25, 28, 32, 35, 36, *38*, 39, *40*, 46, 47, *48*, 49, 52, 55, 56, *58*, *59*, 62, 70, 72, *79*

Inhibitor Sweetening



This is a continuous, chemical treating process to sweeten low mercaptan content gasoline using a phenylene-diamine type inhibitor, air, and caustic.

Inhibitor and air are injected between stages during caustic washing. Mercaptan disappearance may be contributed first to reaction with caustic, then to oxidation to disulfides both during washing and in storage. Traces of caustic must be carried with gasoline to effect rapid storage sweetening.

Cracked gasoline of low mercaptan sulfur content may be inhibitor sweetened in absence of caustic but the reaction is accompanied by excessive peroxide formation.

Inhibitor sweetening has been used extensively with numerous variations since its discovery in 1946, but generally in connection with caustic washing to minimize disulfide and peroxide formation. Peroxides contribute to deterioration of stability, with subsequent engine uncleanliness.

Phenylene-diamine type inhibitors are marketed by Universal Oil Products Co., Tennessee Eastman Corp., E. I. du Pont de Nemours & Co.

Literature references include:

(1) Barringer, C. M., "Antioxidant Sweetening of Gasolines," *Ind. & Engrg. Chem.*, May 1955, pp. 1022-1027
(2) Rampino, L. D., and M. J. Gorham, "Chemistry of Inhibitor Sweetening," Petroleum Processing, Aug. 1955, pp. 1146-1149
(3) Rosenwald, R. H., "Chemistry of Inhibitor Sweetening," Petroleum Processing, Sept. 1951
(4) Rosenwald, R. H., "Chemistry of Inhibitor Sweetening," Petroleum Processing, Oct. 1956
(5) Walker, H. E., and E. B. Kenney, "Removing and Converting Mercaptans," Petroleum Processing, Apr. 1956

Engineering services available for UOP Inhibitor Sweetening:
PROC DESIGN: *3*, *6*, *8*, 22, 23, *25*, 38, *40*, 47, *48*, 49, *56*, *58*, 60, 62, 70, 72, 78
MECH ENGRG: *3*, *6*, 7, *8*, *17*, 22, 23, *25*, *38*, 39, *40*, 47, *48*, 49, *56*, *58*, 59, 62, *66*, 70, 72, *73*, 78
CONSTR: *3*, *6*, *8*, *17*, 22, 23, *25*, 28, *38*, 39, *40*, 47, *48*, 49, *56*, *58*, 59, 62, *66*, 70, 72, *73*, *79*

Hypochlorite Sweetening

This is a chemical treating process to convert mercaptans in straightrun or natural gasoline to less offensive sulfur compounds. The principal reaction results in disulfides with limited formation of sulfones and sulfonic acids, depending upon reagent strength. Either alkaline-sodium or calcium hypochlorite may be used.

Reagent may be prepared in the refinery by passing chlorine gas through a 10% alkaline solution at 95° F. Prepared bleaching powder (calcium hypochlorite) which contains about 65% chlorine may also be purchased.

When more than a trace of hydrogen sulfide is present, an alkaline prewash reduces chemical costs and prevents the formation of elemental sulfur. An alkaline after-wash is frequently necessary to remove undesirable chlorinated by-products. Treating temperatures are 95-110° F.

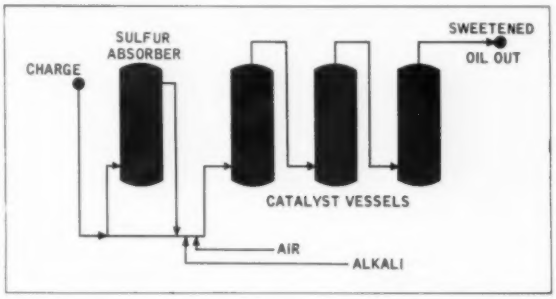
The process became well-established in the 1930's, but is now limited to the treating of natural gasoline and special solvents. Simplicity of the process remains an advantage, even with unfavorable economics because of the high cost of chlorine.

Literature references include:

(1) Birch, S. F., "Hypochlorite Process in Refining," *Oil & Gas J.*, May 23, 1929, pp. 190-194
(2) Birch, S. F., "Application of Hypochlorite Process," *Oil & Gas J.*, May 30, 1929, p. 38+
(3) Bottomly, H., "Economics in Hypochlorite Treating," *Ref. & Nat. Gaso. Mfr.*, Sept. 1936, pp. 359-362
(4) Dunstan, A. E., and B. T. Brooks, "Refining of Gasoline and Kerosene by Hypochlorites," *Ind. & Engrg. Chem.*, Dec. 1922, pp. 1112-1115
(5) Kalichevsky, V. A., "Sweetening and Desulfurization of Light Petroleum Products—Hypochlorite Treatment," *Pet. Ref.*, Feb. 1951, pp. 95+
(6) Kirkwood, G. M., "Treating Pennsylvania Gasoline and Kerosene with Hypochlorite," *Pet. Engr.*, Feb. 1932, p. 108
(7) *Ref. & Nat. Gaso. Mfr.*, "Treating Natural Gasoline with Various Types of Hypochlorite Solutions," July 1933, p. 278
(8) Reid, G. W., "Modern Treating Methods in Refining," *Oil & Gas J.*, June 11, 1925, p. 119
(9) Ziegenhain, W. T., "Simplify Gasoline Treating Problems," *Oil & Gas J.*, July 9, 1931, p. 29

Engineering services available for Hypochlorite Treating:
PROC DESIGN: *6*, *8*, *17*, 23, *25*, 35, 36, *40*, *48*, *49*, *52*, 56, *58*, *60*, *62*, 70, 75
MECH ENGRG: *6*, *8*, *17*, 23, *25*, 35, 36, *39*, *40*, *48*, *49*, *52*, 56, *58*, *62*, 70
CONSTR: *6*, *8*, *17*, 23, *25*, 36, *39*, *40*, *48*, *49*, *52*, 56, *58*, *62*, 70, *79*

Bender Process



Developed by Sinclair Refining Co. at Marcus Hook, Pa. in 1940 and licensed by the Petreco Division of Petrolite Corp., this is a continuous, fixed-bed chemical treating process to sweeten gasoline, kerosine, jet fuel or No. 2 fuel, employing lead sulfide catalyst. Sweetening is effected by converting mercaptans to disulfides by oxidation.

Controlled amounts of sulfur, alkali, and air are added to the product stream and filtered through lead sulfide catalyst beds. Proper control leads to a sweet, non-corrosive product.

Literature references include:

(1) Altshuler & Graves, "Refinements in Sweetening Technique," *Ref. & Nat. Gaso. Mfr.*, June 1937, p. 272
(2) Bender, R. O., U. S. Patent 2-272-594-6, July 21, 1942
(3) Ealey, L., "Bender Lead Sulfide Process Proves Economical," *Oil & Gas J.*, Jan. 22, 1942, pp. 25-27
(4) Fritz, I. T., "Bender Lead Sulfide Treating Process," *Oil & Gas J.*, Feb. 23, 1950, p. 180

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

(5) Happel & Robertson, "Lead Sulfide . . . Dry Sweetening Agent," *Oil & Gas J.*, Mar 31, 1938, p. 125
(6) Waterman, L. C., and R. A. Wiley, "Bender Process Sweetens at No Loss," *Pet. Ref.*, Sept. 1955, p. 182

Engineering services available for the Bender Process:
PROC DESIGN: 8, *23*, *25*, *40*, 53, *56*, *58*, *62*
MECH ENGRG: 7, 8, *23*, *25*, 39, *40*, *52*, 53, *56*, *58*, *59*, *62*
CONSTR: *23*, *25*, 28, 39, *40*, *52*, *56*, *58*, *59*, *62*

COPPER SWEETENING

Copper sweetening of hydrocarbon streams consists of converting mercaptans to disulfides by contact with oxygen in the presence of copper chloride. Cupric chloride is reduced to cuprous chloride during the mercaptan conversion. Cuprous chloride is regenerated to cupric chloride with oxygen.

Copper sweetening is applied commercially as a continuous treating operation in three variations, solid, slurry, and solution. Generally the solid process is applied to light straightrun gasoline while the wet process can handle all stocks, including cracked distillates.

The refinery stream is treated to remove reactive nitrogen and sulfur compounds (H_2S and free S). Oxygen or air is injected to the stream and it is contacted with copper chloride catalyst at 80-120° F. The treated stream is settled to recover catalyst, washed with water or sulfide solution, and protected with metal deactivator before going to storage. In the solution process, catalyst is regenerated by air blowing in a separate tank. Catalyst make-up requirements are slight.

Copper sweetening is simple, but the catalyst is corrosive, and there is no reduction of total sulfur.

Copper sweetening is still practiced extensively, but is being replaced by processes which remove sulfur.

The first installation was made in early 1931. It was offered as an alternate to the then-popular doctor treating process.

Literature references include:

(1) Happel, J. et al., "Critical Analysis of Sweetening Processes and Mercaptan Removal," *Oil & Gas J.*, Nov. 12, 1942, p. 136
(2) *Oil & Gas J.*, "Copper Chloride Treater Handles Straight-Run or Cracked Gasoline," Apr. 10, 1941, p. 37
(3) *Pet. Ref.*, "Skelly Blends Gasoline Before Sweetening," June 1945, pp. 220-221
(4) Robinson, P. M., "Total Removal of Sulfur Compounds is Goal of Sweetening Technique," *Nat. Pet. News*, Aug. 21, 1940, pp. R298-300
(5) Schulze, W. A. & A. E. Buell, "Sweetening Gasoline More Effective, Less Expensive with Cupric Chloride," *Nat. Pet. News*, Oct. 23, 1935, pp. 24e, 24f, 24h
(6) Schulze, W. A., and F. E. Frey, U. S. Patent 1,980,555, Nov. 13, 1934
(7) Schulze, W. A. & L. S. Gregory, "Solution and Gasoline Losses Low in Copper Sweetening Processes," *Nat. Pet. News*, Oct. 7, 1936, pp. 34+

Perco Copper Sweetening

Licensed by Phillips Petroleum Co., either the liquid, solid, or slurry process is available.

Gasoline stable to color and gum in the presence of air is mixed with air and filtered through a solid bed of absorbent material impregnated with copper reagent.

All other stocks are contacted with copper solution in the absence of air and the copper solution is regenerated in a separate tank. Gasoline is sodium sulfide washed to remove traces of copper.

Reagent is made up with copper sulfate and sodium chloride in the liquid process.

Literature references include:

(1) Albright, J. C., "Two in One Copper Sweetening Unit Lowers Treating Inhibitor Costs," *Nat. Pet News*, Oct. 6, 1937, pp. R211-212
(2) Conn, M. W., "Perco Copper Sweetening," *Inst. Pet. J.*, May 1941, p. 196A
(3) *Pet. Ref.*, "Perco Solid Copper Sweetening Process," Apr. 1940, pp. 113-116

Engineering services available for Phillips Copper Chloride Sweetening:
PROC DESIGN: *6*, *8*, 15, *17*, 22, *23*, *25*, *29*, 36, 46, 47, *48*, *52*, 54, 56, *58*, *62*, 70, 72
MECH ENGRG: *6*, 7, *8*, 15, *17*, 22, *23*, *25*, 36, *39*, 46, 47, *48*, *52*, 56, *58*, *59*, *62*, 70, 72
CONSTR: *6*, *8*, 15, *17*, 22, *23*, *25*, 28, *29*, 36, *39*, 46, 47, *48*, *52*, 56, *58*, *59*, *62*, 70, *72*

UOP Copper Sweetening

Available from Universal Oil Products Co., this is a fixed-bed process to sweeten gasoline.

Stock is caustic washed, then washed with hydrochloric acid to neutralize alkalinity and remove organic base compounds. Contact is then made with copper reagent in a bed of Italian pumice at about 100° F. Temperature is dependent upon the molecular weight of mercaptans. Trace copper is removed by contact with zinc sulfide or pumice.

Reagent consists of a compound of ammonium chloride and copper sulfate.

Literature references include:

(1) *Ref. & Nat. Gaso. Mfr.*, "Cushing Plant Has New Copper Treating Unit," Apr. 1940, pp. 117-119

Engineering services available for copper chloride sweetening:
PROC DESIGN: *3*, *6*, *8*, 22, *23*, 25, *29*, *32*, 35, *40*, 46, 47, *48*, *52*, 56, *58*, *62*, 72, 78
MECH ENGRG: *3*, *6*, 7, *8*, *17*, 22, *23*, 25, 35, 39, *40*, 46, 47, *48*, *52*, 56, *58*, *59*, *62*, *66*, 72, *73*, 78
CONSTR: *3* *6*, *8*, *17*, 22, *23*, 25, 28, *29*, *32*, 35, 39, *40*, 46, 47, *48*, *52*, 56, *58*, *59*, 61, *62*, *66*, 72, *73*, *79*

Linde Copper Sweetening

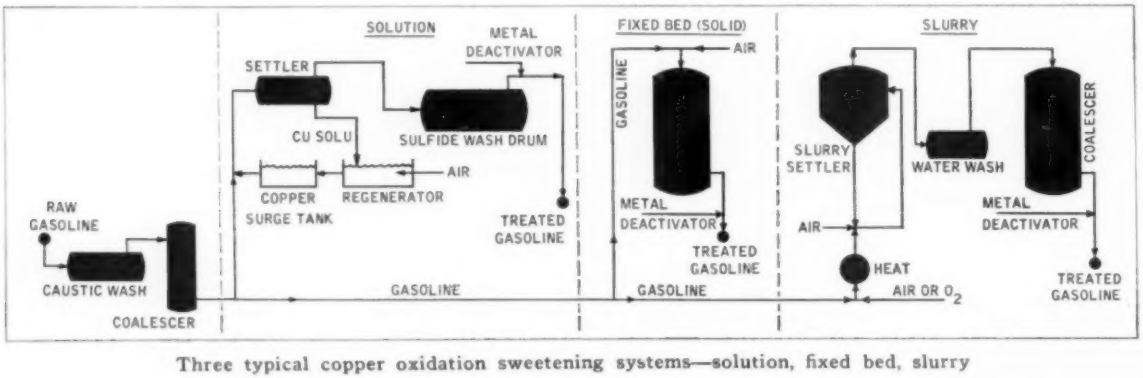
In commercial use since 1935, this process is licensed by Linde Air Products Co. and is a slurry process to treat straightrun or cracked gasolines and distillates.

Reagent is made up with 200 mesh clay and cupric chloride.

Charge stock is heated, has oxygen added, and is contacted with a clay-cupric chloride-slurry at 80-100° F. The mixture is settled and stock is drawn off and washed with sodium sulfide to remove traces of copper.

Literature references include:

(1) Atkinson, R. G., "Slurry-Type Copper Treater Stops Octane Number Losses," *Nat. Pet. News*, Dec. 11, 1940, pp. R-450-452



Three typical copper oxidation sweetening systems—solution, fixed bed, slurry

(2) Deering, F. A., "Slurry-Type Copper Chloride Treater," *Oil & Gas J.*, Sept. 5, 1940, pp. 43-4
(3) Mann, G. L., "Technology, Operation, and Results from Linde Copper Sweetening Process," *Oil & Gas J.*, Mar. 22, 1947, pp. 195-202
(4) Schieman, C. T., "Linde Copper Sweetening Process," *Pet Engr.*, May 1947, pp. 184-190

Engineering services available for Linde Copper Sweetening:
PROC DESIGN: 8, *17*, 23, *25*, 29, 38, 46, *48*, 49, *52*, 56, *58*, 60, *62*, 70, *72*
MECH ENGRG: 7, 8, *17*, 23, *25*, 38, 39, 46, *48*, 49, *52*, *56*, *58*, 59, *62*, 70, *72*
CONSTR: 8, *17*, 23, *25*, 28, *29*, 38, 39, 46, *48*, 49, *52*, *56*, *58*, 59, *62*, 70, *72*, 79

Airco-Hoover Sweetening

Furnished by Air Reduction Sales Co., this is a slurry process to sweeten gasoline.

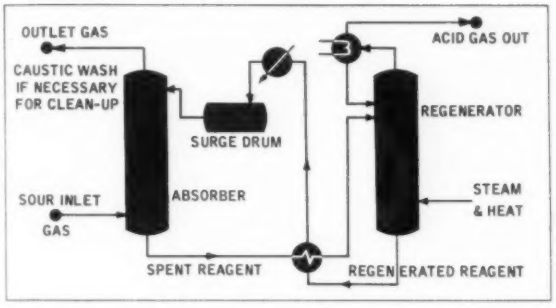
Reagent consists of copper chloride impregnated on diatomaceous earth in a slurry form. Oxygen is used for reagent regeneration.

Stock is caustic washed, water washed, and dried in a salt bed. Oxygen is added in a gasoline slip stream. Charge stock is heated (to increase water solubility) and passed through the reagent slurry in the reactor. Overflow stock from phase-settling is water washed, settled, and taken to storage.

Literature references include:

(1) Hoover, C. D., "Use of Oxygen in Gasoline Treating," *Pet. Ref.*, July 1948, pp. 99-103

HYDROGEN SULFIDE REMOVAL



The elimination of hydrogen sulfide and other acidic material from natural and refinery gases has become increasingly important in recent years.

Popular processes are those which use a regenerable reagent and recover the hydrogen sulfide. In operation and principle the processes are similar. Gases are contacted in towers counter-currently with alkaline solutions. Spent solutions are blown with steam and heated to remove hydrogen sulfide and regenerate the solution.

Whether other material, such as carbon dioxide, hydrogen cyanide, mercaptans, carbonyl sulfide, carbon disulfide, and water vapor, is present will influence the choice of process.

The use of caustic, except for the removal of trace amounts of acid gases, has been largely abandoned because of excessive cost and disposal problems.

Processes employing air blowing to regenerate reagent contribute to air contamination whether spent to the atmosphere directly or fed to a furnace.

Removal processes are as follows:

Name	*Reaction*	*Regeneration*
Caustic Soda	$2NaOH + H_2S \rightarrow Na_2S + 2H_2O$	None
Lime	$Ca(OH)_2 + H_2S \rightarrow CaS + 2H_2O$	None
Iron Oxide	$FeO + H_2S \rightarrow FeS + H_2O$	Partly by air
Seaboard	$Na_2CO_3 + H_2S \rightleftarrows NaHCO_3 + NaHS$	Air blowing
Thylox	$Na_4AS_2S_8O_2 + H_2S \rightarrow Na_4AS_2S_6O + H_2O$	Air blowing
	$Na_4AS_2S_6O + \frac{1}{2}O_2 \rightarrow Na_4AS_2S_6O_2 + S$	
Girbotol	$2RNH_2 + H_2S \rightleftarrows (RNH_3)_2S$	Steaming
Phosphate	$K_3PO_4 + H_2S \rightleftarrows KHS + K_2HPO_4$	Steaming
Phenolate	$NaOC_6H_5 + H_2S \rightleftarrows NaHS + C_6H_5OH$	Steaming
Vacuum Carbonate	$Na_2CO_3 + H_2S \rightleftarrows NaHCO_3 + NaHS$	Vacuum steaming

General literature references include:

(1) Baehr, Hans, "Gas Purification and Sulfur Recovery," *Ref. & Nat. Gaso. Mfr.*, June 1938, pp. 237-244
(2) Carvlin, G. M., "The Use of Sodium Phenolate for Hydrogen Sulfide Removal," *Ref. & Nat. Gaso. Mfr.*, June 1938, pp. 225-233
(3) Gregory, L. B., and W. G. Scharmann, "Carbon Dioxide Scrubbing by Amine Solutions," *Ind. & Engrg. Chem.*, May 1937, pp. 514-520
(4) Powell, A. R., "Recovery of Sulfur from Fuel Gases," *Ind. & Engrg. Chem.*, July 1939, p. 789-796

Girbotol

Developed by and available from the Girdler Co., this is a continuous, regenerative process to separate hydrogen sulfide, carbon dioxide, and other acid impurities from natural gas, refinery gas, etc., utilizing an organic amine reagent (mono-, di-, or tri-ethanolamine). The reagents are frequently referred to as MEA, DEA and TEA.

Ethanolamines are strong, water soluble bases having an affinity for hydrogen sulfide at temperatures to 160-180° F. When heated to temperatures above 200° F, they become less basic in nature and lose affinity for hydrogen sulfide.

Impure gas is contacted countercurrently with regenerated amine solution in an absorber (i. e., packed tower with Raschig rings) at line temperatures (100-150° F) and pressures. Hydrogen sulfide-rich amine solution is heated to 200° F or above by heat exchange with regenerated reagent, then steam stripped to remove acid gases. Amine solution is cooled to about 100° F and returned to the absorber through a surge drum.

Selection of reagent depends upon the particular refining situation and the product requirements. Liquid hydrocarbons may also be treated using a similar procedure.

The first natural gas application for hydrogen sulfide removal was at the Shell Oil Co. plant at Hobbs, N. M. It was not until 1938, at the Atlantic Refining Co. refinery near Port Arthur, Texas, that hydrogen sulfide was removed from refinery gas using the Girbotol process.

Literature references include:

(1) Bottoms, R. R. & W. R. Wood, "The Girbotol Purification Process," *Ref. & Nat. Gaso. Mfr.*, Mar. 1935, pp. 105-107
(2) Gordon, J. D., "Liquid Hydrocarbon Treating with Aqueous Amine Solutions," *Oil & Gas J.*, Apr. 13, 1944, p. 202
(3) Gregory, L. B. & W. G. Scharmann, "Carbon Dioxide Scrubbing by Amine Solutions," *Ind. Engrg. Chem.*, May 1937, pp. 514-520
(4) Norris, W. E., and F. R. Clegg, "Investigation of Girbotol Unit Charging Cracked Refinery Gases Containing Organic Acids," *Pet. Ref.*, Nov. 1947, p. 739-741
(5) Reed, R. M., "Improved Design, Operating Techniques for Girbotol Absorbtion Processes," PETROLEUM PROCESSING, Dec. 1947, p. 907
(6) Starrs, B. D., and R. M. Reed, "Application of the Girbotol Process to Industry," *Nat. Pet. News*, Oct. 29, 1941, p. R350
(7) Wood, N. R., and B. D. Starrs, "The Girbotol Purification Process," *Ref. & Nat. Gaso. Mfr.*, June 1938, pp. 234-236

Engineering services available for Girbotol:
PROC DESIGN: 5, 6, 8, 11, 17, *19*, 22, 23, 26, 27, 36, 38, 40, 47, 49, *58*, 60, 62, 63, 70
MECH ENGRG: 6, 8, 11, 17, *19*, 21, 22, 23, 27, 36, 38, *39*, 40, 47, 49, 51, *58*, 59, 62, 70
CONSTR: 6, 8, 11, 17, *19*, 21, 22, 23, 26, 27, 28, 36, 38, *39*, 40, 47, 49, *58*, 59, 62, 63, 70

Glycol-Amine Gas Treating

Developed and licensed by Fluor Corp., Ltd., this is a continuous, regenerative process to simultaneously dehydrate and remove acid gases from natural or refinery gas. A mixture of an aqueous amine (generally monoethanolamine) and di- or tri-ethylene glycol make up the treating reagent. A typical solution might contain 20% amine, 70% glycol, and 10% water.

Sour gas is contacted countercurrently in a bubble-tray tower with regenerated solution at approximately 100° F and

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

operating line pressure. Purified gas is removed at the tower top. Spent reagent is heated by exchanger (regenerated solution), charged to a regenerator at about 300° F, and steam stripped. Excess water and acid gases are removed, reagent is cooled and returned to the top of the bubble-tray tower.

The reagent boiling point is raised by the presence of glycol so that acid gases may be stripped at a low regenerator pressure.

Literature references include:

(1) Chapin, W. F., "High Purity Natural Gas by the Glycol-Amine Process," *Pet. Ref.*, June 1947, p. 109

Engineering services available for Glycol-Amine Gas Treating:
PROC DESIGN: 5, 22, 25, 27, 56, *58*
MECH ENGRG: 22, 25, 27, *39*, *58*
CONSTR: 22, 25, 27, 28, *39*, *58*

Phosphate Desulfurization

Licensed by Shell Development Co., this is a continuous, regenerative process to separate hydrogen sulfide from natural gas, refinery gas, or liquid hydrocarbons by means of tripotassium phosphate solution. Solution contains about 30% tri-potassium phosphate in water, and will selectively absorb hydrogen sulfide in the presence of carbon dioxide.

Sour gas is contacted countercurrently with regenerated reagent in a bubble-plate extractor at about 100° F (temperatures as high as 200° F are possible) and operating gas pressure. Purified gas is removed from the extractor top. Spent reagent, carrying hydrogen sulfide, is removed from the extractor base, heated by exchange (regenerated reagent), charged to the regenerator, and steam stripped at about 240° F. Hydrogen sulfide and water vapor are taken from the top of the regenerator. Open steam can be used for stripping, in which case a reconcentrator operates in conjunction with the regenerator to regulate the water content of the reagent. Regenerated reagent is then cooled and returned to the extractor.

For liquid hydrocarbon treating and some gas treating, reagent is returned to the extractor top as a single stream. Packed towers are generally used to extract hydrogen sulfide from liquids.

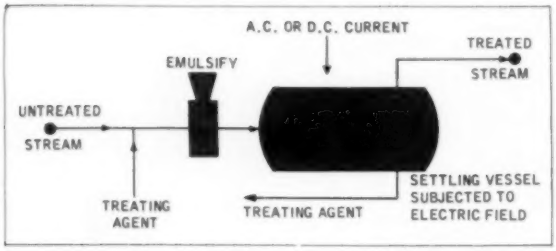
In treating some gases, the reagent is returned to the extractor from two points of the regenerator, and consists of a lean reagent and a very lean reagent. The very lean reagent is charged to the top of the extractor while the lean reagent is charged further down to contact the more sour gas. A large steam saving is effected by the practice.

Literature references include:

(1) LaCroix, H. N., and L. J. Coulthurst, "Hydrogen Sulfide Removal," *Ref. & Nat. Gas. Mfr.*, Aug. 1939, pp. 90-94
(2) Mullen, J. M., "Hydrogen Sulfide Removal by Using Tripotassium," *Oil & Gas J.*, Apr. 13, 1939, pp. 37-38
(3) Rosebaugh, T. W., "The Shell Phosphate Process for the Removal of Hydrogen Sulfide," *Ref. & Nat. Gaso. Mfr.*, June 1938, pp. 245-247+

Engineering services available for Phosphate Desulfurization:
PROC DESIGN: *8*, *17*, 23, *25*, *27*, *36*, 38, 49, 56, *58*, *62*, 64, 70
MECH ENGRG: *8*, *17*, 22, 23, *25*, *27*, *36*, 38, *39*, 49, *58*, 59, *62*, *70*
CONSTR: *8*, *17*, *22*, 23, *25*, 27, 28, *36*, 38, *39*, 49, *58*, 59, *62*, *70*, *79*

ELECTRIC TREATING



The principle of breaking oil-water emulsions with the aid of electricity has been applied to the field of desalting since the mid-1930s. Recently the process has been improved to include emulsion breaking in acid or acid sludge treating, caustic treating, doctor treating, etc. A wide variety of refinery streams may be treated.

The hydrocarbon stream is intimately mixed with the treating agent at appropriate temperature and pressure conditions. The mixture is then introduced into an electric process vessel for rapid coagulation of the treating agent.

When alternating current is used, treating-agent particles are caused to vibrate in a high potential field. Particle contact is increased to the extent that small droplets unite and rapidly settle.

When direct current is used for emulsion breaking, particle contact is increased by controlled migration toward the positive electrode. When sufficiently coagulated, the treating agent settles.

General claims for electric treating are that much better contact is possible with very rapid settling. At the same time, chemical consumption is reduced and carry-over is lowered to a minimum.

Electrofining

Licensed by the Petreco Division of Petrolite Corp., this is a continuous electric process used with a wide variety of chemical treating processes to provide rapid separation of hydrocarbon-reagent dispersions. The process may be applied to treating of gasoline, kerosene, diesel fuel, lube distillates and other refinery products.

Reagent is dispersed into the refinery stream under the conditions required for the particular treating process being applied, and the mixture is subjected to the action of an electrostatic field in a settling vessel. Separation of reagent facilitates its continuous withdrawal and recycle.

Normal electrical requirements are for a 460-volt, 60-cycle system, and power consumption is stated as low.

Electrofining was applied for the first time to continuous Doctor treating at the Coop Refinery at Coffeyville, Kans., in late 1952. The first commercial unit for desludging acid-treated, thermally-cracked gasoline (16,000 b/d) was installed at the Torrence, Calif., refinery of the General Petroleum Corp. in 1952.

Literature references include:

(1) *Pet. Ref.*, "First Unit Electrofining—Doctor Treating," Sept. 1955,, pp. 184-185
(2) *Pet. Ref.*, "Three Electric Processes—Electric Distillate Treating," Sept. 1953, pp. 125-129

Available engineering services for Electrofining:
PROC DESIGN: *8*, *17*, *23*, *25*, 28, 38, *40*, 42, *49*, *52*, 53, *56*, *58*, *62*
MECH ENGRG: *8*, *17*, *23*, *25*, 28, 38, *39*, 40, 42, *49*, *52*, 53, *56*, *58*, *59*, *62*
CONSTR: *8*, *17*, *23*, *25*, *38*, *39*, *40*, *49*, *52*, *56*, *58*, *59*, *62*

Electrical Precipitation

Licensed by the Howe-Baker Corp., this is a continuous, electric process to improve separation of hydrocarbon-reagent dispersions. Application is made to most chemical treating processes and a wide variety of refinery stocks.

Feed stock is mixed with treating reagent in a mixing valve and discharged into the precipitator vessel. The mixture is separated by passage through an electric field, then product is taken to storage, water and reagent free. Reagent is continuously removed from the bottom of the vessel and recirculated until spent. Temperature control is not critical but will generally be 100-150° F (stream conditions) while pressure is set by the stock being treated.

Equipment cost is stated at about $50,000 for electrifying an existing vessel and includes power supply, electrode assemblies, electrical controls, etc.

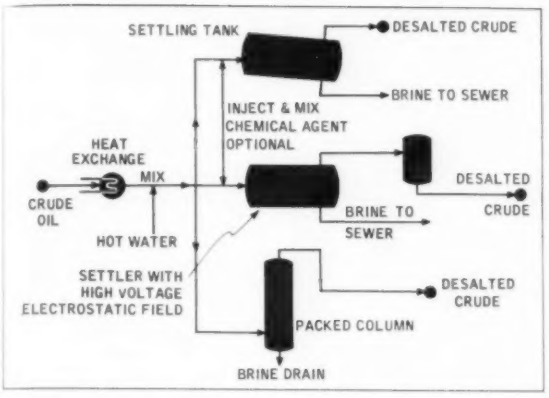
The first commercial installation was applied to caustic and water washing of catalytic heating oil in a Gulf Coast refinery about two years ago.

Literature references include:

(1) Phillips, R. J., "Cut Costs in Distillate Treating," *Pet. Ref.*, Sept. 1955, pp. 194-202

Available engineering services for Electric Desulfurization:
PROC DESIGN: *8*, *17*, *23*, *25*, 35, 38, 42, 49, *52*, *56*, *58*, *62*, *72*
MECH ENGRG: 7, *8*, *17*, *23*, *25*, 35, 38, *39*, 42, 49, *52*, *56*, *58*, *59*, *62*, *72*
CONSTR: *8*, *17*, *23*, *25*, 28, 35, 38, *39*, 49, *52*, *56*, *58*, *59*, *62*, *72*

DESALTING



Brine containing sulfates and chlorides is often associated with crude oil in the form of droplets in suspension or emulsions. Inorganic salts, particularly chlorides, break down during processing and cause serious corrosion and fouling of equipment, causing reduced throughput and other undesirable side effects. Removal of these salts is often essential to maintain an economical operating cycle. A salt content of 20 lb/1000 bbl is considered a maximum that can be tolerated in crude oil, but desalting operations are generally aimed at a much lower figure.

Three general approaches have been taken to the desalting of crude oil: mechanical, chemical and electrical. Numerous variations of each have been devised and their efficiency is dependent upon the type of salt dispersion, viscosity of crude, etc.

Simple brine suspensions often may be removed from crude oil by heating under pressure necessary to prevent vapor loss (200-300° F and 50-250 psig) then settling in a large vessel. Coalescence is aided by passage through packed towers (sand, gravel, excelsior, fiber glass, etc.)

The use of chemicals is often necessary to break the more stable emulsions of brine. Oil is generally heated, mixed with wash water and chemicals, then settled for from a few minutes to 2 hours. Treating agents available include alkaline brines, soaps, fatty acids, sulfonates, and long chain alcohols.

A high potential field across the settling vessel will also aid coalescence and is used both with and without the aid of chemicals.

Crude oil desalting has been in use since the early days of the refining industry.

General literature references include:

(1) Allison, J. J., "Electric Dehydrating and Desalting," *Ref. Nat. Gaso. Mfr.*, June 1937, p. 267
(2) Armistead, G., Jr., "The Desalting of Petroleum Oils," *Oil & Gas J.*, Mar. 23, 1946, pp. 81-89
(3) Blair, C. M., Jr., "Removal of Inorganic Salts from Petroleum," *Oil & Gas J.*, Apr. 4, 1940, p. 52
(4) Egloff, G., et al, "Improper Acidizing Presents Desalting Problems to Refining Industry," *Oil & Gas J.*, Oct. 14, 1937, pp. 57-58 & Oct. 21, 1937, p. 66
(5) Foster, A. L., "Desalting Crude Oil," *Pet. Engrg.*, Aug. 1951, pp. C34-C38
(6) Fugua, F. D., "Crude Oil Desalting in Refining Operations," *Pet. Ref.*, Apr. 1946, pp. 140-146
(7) Jones, E. R., "Salt Removal from Crude Oil," *Ref. Nat. Gaso. Mfr.*, May 1937, pp. 208-210
(8) Van Dedem, G. W., "Chemical Methods for Separating Petroleum Emulsions," *Oil & Gas J.*, Aug. 12, 1937, p. 65

Electric Desalting—Petreco

Licensed by the Petreco Division of Petrolite Corp., this is a continuous process to eliminate inorganic salts and other impurities from refinery charge stock by means of electric precipitation.

From 2-15% water is emulsified in the untreated crude oil and heated to 180-240° F. Operating pressure is that of the crude system. The emulsion is broken upon being subjected to a high-potential electrostatic field in a suitable settling vessel. Dissolved salts and impurities are then removed with the water.

Literature references include:

(1) Albright, J. C., "Salt Removal from Refinery Charge Stock," *Pet. Engr.*, Nov. 1941, p. 94
(2) Bonaurtz, W. A., et al, "Desalting Crude Oil," *Pet. Engr.*, Nov. 1947, p. 98
(3) Hanson, G. B., "The Extraction of Salts from Refinery Charging Stocks by the Electric Process," *Ref. Nat. Gaso. Mfr.*, May 1937, pp. 211-213
(4) St. Hill, T. N., and G. B. Hanson, "Extraction of Salts from Refinery Stocks by the Electrical Process," *Ref. Nat. Gaso. Mfr.*, Oct. 1937, pp. 466-469

Available engineering services for Petrolite Electric Desalting:
PROC DESIGN: 6, 8, *11*, *17*, 22, 23, *25*, 32, 36, 38, *40*, 46, 47, *48*, 49, *52*, 56, *58*, 70, 72
MECH ENGRG: 6, 8, *11*, *17*, 22, 23, *25*, 36, 38, *39*, *40*, *42*, 43, 46, 47, *48*, 49, *52*, 56, *58*, 59, 70, 72
CONSTR: 6, 8, *11*, *17*, 22, 23, *25*, 28, 32, 36, 38, *39*, *40*, *42*, 46, 47, *48*, 49, *52*, 56, *58*, 59, 70, 72, 76

Electric Desalting—Howe-Baker

Licensed by Howe-Baker Corp., this is a continuous process to eliminate inorganic salts and other impurities from raw crude oil based on the principle of settling in an electrostatic field.

From 4-8% water is intimately mixed with crude oil and heated to 125-250° F (operating pressure of the crude system may be maintained). Injection of emulsion-breaking chemical may be made when necessary. The stable emulsion is then pumped to a settler where the aqueous phase is dropped-out by the application of a high-voltage electrostatic field.

Literature references include:

(1) Foster, A. L., "Desalting Crude Oil," *Pet. Engr.*, Aug. 1950, pp. C34-38

Available engineering services for Howe-Baker Electric Desalting:
PROC DESIGN: 6, 8, *17*, *22*, *23*, *25*, 35, *36*, 38, 46, 47, 48, 49, *52*, *56*, *58*, *62*, *72*
MECH ENGRG: 6, 7, 8, 11, *17*, *22*, *23*, *25*, 35, *36*, 38, *39*, *42*, 46, 47, 49, *52*, *56*, *58*, *59*, *62*, *72*
CONSTR: 6, 8, 11, *17*, *22*, *23*, *25*, 28, 35, *36*, 38, *39*, *42*, 46, 47, 48, 49, *52*, *56*, *58*, *59*, *62*, *72*

Chemical Desalting

Chemical emulsion breakers are compounded and marketed specifically for chemical crude oil desalting as described in the introduction to the Crude Oil Desalting section.

Design of chemical desalting equipment varies widely, and no specific process is licensed. Service and assistance may generally be obtained from the chemical supplier.

When using a chemical for emulsion breaking during desalting, it may be added to one or more of three points in the system:

1—To oil before it is emulsified with fresh water
2—To fresh water before mixing with oil
3—To mixture of oil and water.

Chemical emulsion breakers are available from Tetrolite Division, Petrolite Corp, and Visco Products Co.

Literature references include:

(1) Blair, C. M. Jr., "Removal of Inorganic Salts from Petroleum," *Oil & Gas J.*, Apr. 4, 1940, p. 52
(2) Kirkpatrick, W. H., "Chemical Treating of Crude Oil Emulsions," *Pet. Ref.*, Nov. 1948, pp. 622-624
(3) Van Dedem, G. W., "Chemical Methods for Separating Petroleum Emulsions," *Oil & Gas J.*, Aug. 12, 1937, p. 65

Available engineering services for Chemical Desalting:
PROC DESIGN: 6, 8, *17*, *23*, *25*, 32, *36*, 38, *40*, 46, 47, *48*, *49*, *52*, 56, *58*, 62, 70
MECH ENGRG: 6, 8, *17*, 23, *25*, *36*, 38, *39*, *40*, *42*, 46, 47, *48*, *49*, *52*, 56, *58*, *59*, 62, 70
CONSTR: 6, 8, *17*, 23, *25*, 28, 32, *36*, 38, *39*, *40*, *42*, 46, 47, *48*, *49*, *52*, 56, *58*, *59*, 62, 70

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

MISCELLANEOUS PROCESSES

DEHYDROGENATION

Dehydrogenation is a process for splitting hydrogen from a hydrocarbon or mixture of hydrocarbons, either catalytically or thermally. In the catalytic process, either mono- or diolefins may be produced.

Thermal dehydrogenation has been used to some extent with gas fuels such as ethane, isobutane, etc. for special refining situations. The process is less selective than the catalytic operation and tends to form lighter molecules in preference to the desired olefin. Operating conditions range from 1400-2200°F and 5-50 psia.

Catalytic dehydrogenation has developed in recent years in the production of basic materials (butadiene) for the synthesis of rubber, resins and other petrochemicals.

The process is selective and may be adapted to a number of feed stocks. Catalysts in general consist of metal oxides supported on ceramic or alumina bases (Cr_2O_3, NiO, TiO_2, etc.). Operating temperatures range from 932-1380°F with pressures of about 1 atm. The operating cycle is short and catalyst must be regenerated frequently in the presence of air at from 1100-1300°F.

Main application for the process during World War II was to produce additional olefin feed for alkylation. Because of renewed interest in alkylation of motor fuel, attention has again been directed toward dehydrogenation as a means of providing olefin feed from saturated gases.

Another significant fact is that hydrogen may be obtained as a by-product in the range of about 80% purity.

General dehydrogenation references include:

(1) Burgin, J. et al, "Dehydrogenation of the Lower Paraffins over Activated Alumina Catalysts," *Oil & Gas J.*, Sept. 8, 1938, pp. 48-55
(2) Frey, F. E., and W. F. Huppke, "Equilibrium Dehydrogenation of Ethane, Propane & Butanes," *Ind. & Engrg. Chem.*, Jan. 1933, pp. 54-59
(3) Heinemann, Heinz, "Digest of U.S. Patents (29) on Dehydrogenation and Dehydrodehalogenation of Hydrocarbons," *Pet. Ref.*, Apr. 1944, pp. 142-154
(4) Karzhev, V. I. et al, "High Octane Gasoline Obtained by Catalytic Dehydrogenation," *Oil & Gas J.*, June 9, 1938, pp. 50-53
(5) Komarewsky, V. I., and C. H. Riesz, "Production of Butadiene by Single Stage Catalytic Dehydrogenation of Butane," *Oil & Gas J.*, Sept. 17, 1942, pp. 33-39
(6) Riesz, C. H., "Catalytic Dehydrogenation of Natural Gas Hydrocarbons," *Oil & Gas J.*, July 15, 1944, pp. 67-69, 96

Butane Dehydrogenation

A continuous, catalytic process, licensed by Houdry Process Corp., Philadelphia, Pa., to dehydrogenate light hydrocarbons to their corresponding mono- or diolefins. Mixtures of hydrocarbons may be processed for the manufacture of chemicals, chemical intermediates, and refinery feed stocks.

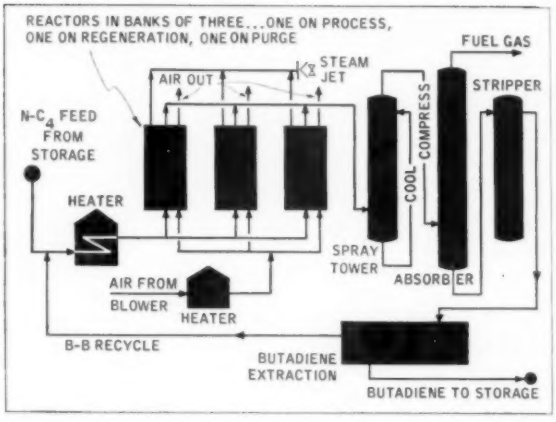
Dehydrogenation is accomplished by passing preheated hydrocarbon vapors, under controlled conditions, over catalysts of the chromic oxide-alumina type $Cr_2O_3 \cdot Al_2O_3$. The process is adiabatic and heat exchange is eliminated within the reactors. Heat capacity of the catalyst bed is controlled by using an inert material in pellet form with the active catalyst.

Regeneration of catalyst is effected with air at elevated temperature. Reactors are arranged in banks of three. One reactor is on the process-cycle while the second is on regeneration receiving air, and the third on purge.

For the production of mono-olefins, approximately atmospheric pressure and temperatures in the range of 1050-1100°F are used. Diolefins are produced at higher temperatures and pressures slightly below atmospheric.

When the process is operated in butadiene production, butadiene is extracted from the reactor effluent and the remaining B-B cut recycled.

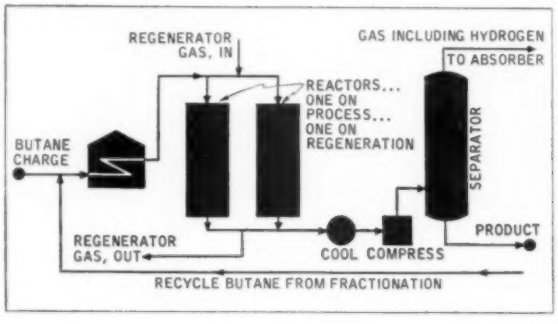
The first commercial plants were operated during World War II by Sun Oil Co. at Toledo, and Standard Oil Co. of Calif. at El Segundo.



Houdry Butane Dehydrogenation references include:

(1) Lassiat, R. C., and F. D. Parker, "Butane Dehydrogenation by the Houdry Process," *Oil & Gas J.*, Nov. 18, 1944, pp. 229
(2) *Pet. Ref.*, "Dehydrogenation," Sept. 1949, pp. 208-209

Dehydrogenation—UOP



A continuous, catalytic dehydrogenation process capable of converting C_2 to C_4 hydrocarbons to corresponding olefins.

Charge material (butane) is heated to from 932 to 1380°F and passed through a catalyst (chromium oxide on alumina) chamber of the tubular heat exchanger type under pressures from 10-50 psi. By recycling and using optimum conditions, 90-95% conversion to olefins is obtained. Reaction is exothermic and catalyst temperature is carefully controlled. Two or more reactors are used on alternate process and regeneration cycles. Reactor effluent is cooled and compressed before separating light gases (H_2, C_1, C_2's and C_3's) from butane and butenes. Fractionation separates the butane for recycle.

Operating cycle is short (about one hour) and catalyst contamination is mainly coke. Sulfur compounds and CO do not materially affect the catalyst, which may be regenerated as many as 2000 times.

UOP Dehydrogenation references include:

(1) Grosse, A. V. et al, "The Catalytic Dehydrogenation Process," *Ref. Nat. Gaso. Mfr.*, Nov. 1939, pp. 100-107
(2) Grosse, A. V., and V. N. Ipatieff, "Catalytic Dehydrogenation of Gaseous Paraffins," *Ind. & Eng. Chem.*, Feb. 1940, pp. 268-272
(3) Grosse, A. V. et al, "Catalytic Dehydrogenation of Mono-olefins to Di-olefins," *Ind. & Eng. Chem.*, Mar. 1940, pp. 309-311
(4) Van Winkle, M., "Aviation Gasoline Manufacture," McGraw-Hill, New York, First Edition, pp. 120-124

HYDROGEN MANUFACTURE

Numerous processes have been developed for the manufacture of hydrogen.

Where small amounts are required with low initial investment, the Steam-Methanol or Ammonia dissociation processes are applicable.

Steam-Methanol involves catalytic cracking of methanol at 300 psi and about 500°F with the formation of hydrogen and carbon dioxide. CO_2 is removed with an amine solution. Low-cost methanol is an essential requirement.

Ammonia dissociation also requires low cost raw material. Gas produced contains 75% hydrogen, 25% nitrogen.

Electrolysis of water produces an extremely pure hydrogen (99.95%+) but power cost must be low (½¢/kwh or less).

The Steam-Iron process is one of the oldest commercial processes for producing hydrogen. Steam is passed over reduced iron oxide at temperatures from 1400-1900°F. Catalyst is regenerated by reversing the reaction with producer or water gas at from 1400-1900°F. Total hydrogen produced in the U.S. from this process is relatively low.

The Steam-Water Gas process has been utilized on a large scale for many years to produce hydrogen for ammonia and methanol syntheses. Water gas (40% CO, 50% H_2) is reacted catalytically (iron oxide activated with chromium) with steam at 700-900°F to produce CO_2 and H_2. Relatively pure hydrogen is obtained by scrubbing out CO_2 with amine solutions.

Every indication points toward hydrogen manufacture as an accepted refinery process in the future. Processes of major interest and use today are Steam-Hydrocarbon Reforming and Partial Oxidation of Hydrocarbons.

General hydrogen manufacture references include:

(1) Arnold, J. H., and W. T. Dixon, "From By-Product Hydrogen to Anhydrous Ammonia," PETROLEUM PROCESSING, Jan. 1956, pp. 62-66
(2) Baker, D. F., "Low Temperature Processes Purify Industrial Gases," *Chem. Engrg. Prog.*, Sept. 1955, pp. 399-402
(3) Brownlie, David, "Bulk Production of Hydrogen," *Ind. & Engrg. Chem.*, Oct. 1938, pp. 1139-1146
(4) Byrne, P. J. et al., "Recent Progress in Hydrogenation of Petroleum," *Ind. & Engrg. Chem.*, Oct. 1932, pp. 1129-1135
(5) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(6) Heinemann, Heinz, "Don't Burn Your Excess Hydrogen," PETROLEUM PROCESSING, July 1953, pp. 1036-1040
(7) James, R. L., "Hydrogen—Its Markets and Potential Uses," Amer. Pet. Inst., Div. of Refining, St. Louis, Mo., May 11, 1955
(8) Murphree, E. V., et al., "Hydrogenation of Petroleum," *Ind. & Engrg. Chem.*, Sept. 1940, pp. 1203-1212
(9) Palazzo, D. F., "Low Temperature Recovery of Hydrogen from Refinery Gases," Div. of Pet. Chemistry, Amer. Chem. Soc., Atlantic City, N. J., Sept. 17-21, 1956
(10) PETROLEUM PROCESSING, "CO-Free Hydrogen Can be Made by Using Waste Thermal Cracking Gas," Apr. 1955, p. 549
(11) PETROLEUM PROCESSING, "How Sohio Makes Ammonia," Feb. 1956, pp. 47-50

Hygirtol Process

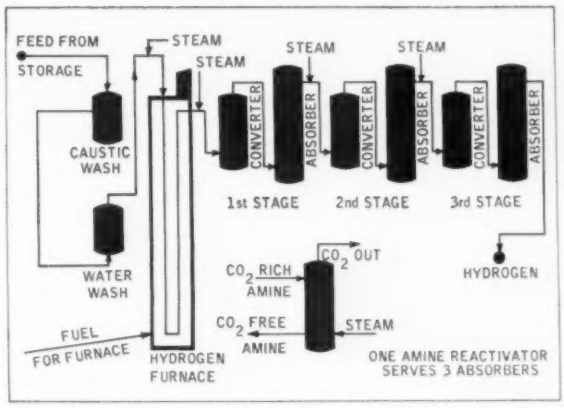
A continuous, catalytic process for the production of hydrogen from steam and hydrocarbons such as natural gas, refinery gases, propane, and butane. Unsaturates and saturates react alike.

Feedstock is washed to remove sulfur compounds, then reacted with steam at about 1500°F in contact with nickel catalyst to form H_2, CO and CO_2. The gas mixture is cooled to 700°F by steam addition and passed over iron oxide catalyst in a converter where CO reacts with steam to form CO_2 and H_2. Converter gas effluent is cooled and CO_2 is removed by amine washing (Girbotol Process). Remaining CO_2 can be removed by the use of additional converters and amine systems or by methanation of the residual CO_2. Typical H_2 by the process is 99.88% pure.

The process is licensed by the Girdler Co., Louisville, Kentucky.

Hygirtol process references include:

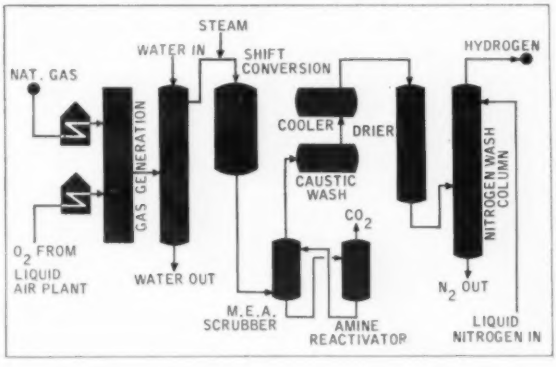
(1) Davidson, R. L., "Hydrogen Processing," PETROLEUM PROCESSING, Nov. 1956, pp. 115-138
(2) Duff, Barrett S., "Ammonia—Cost of Manufacturing from Five Different Raw Materials," PETROLEUM PROCESSING, Feb. 1955, pp. 223-228



(3) Fairclough, Hugh, "What Price Hydrogen," *Pet. Ref.*, Sept. 1956, pp. 333-335
(4) Pfeiffer, Carl and H. J. Sandler, "Ammonia from Cat Reformer Off-Gas—Six Ammonia Synthesis Gas Preparation Processes," *Pet. Ref.*, May 1955, pp. 145-152
(5) Reed, R. M., "Present-Day Hydrogen Manufacturing Processes," *Pet. Ref.*, Aug. 1946, pp. 99-108
(6) Reed, R. M. and Arne Ericksen, "Hydrogen and Synthesis Gas Production," PETROLEUM PROCESSING, Oct. 1948, pp. 1011-1016

Available engineering services for Hygirtol:
PROC DESIGN: *26, 40, 58, 62*
MECH ENGRG: *39, 40, 58, 62*
CONSTR: 19, 26, 28, *39, 40, 58, 62*

Partial Oxidation Process



A continuous, non-catalytic process for the production of hydrogen by partial oxidation of gas or liquid hydrocarbons (i.e., fuel oil, natural gas, etc.). Operation is described as a non-catalytic flame reaction of oxygen with gas or liquid fuel.

Compressed air is scrubbed with caustic to remove CO_2 and dried. Air is then separated by liquefaction into oxygen (95%) and nitrogen (99.99%).

Hydrocarbon feed is preheated and partially oxidized in a generator under controlled conditions with 95% oxygen. Generator effluent (CO, CO_2 and H_2) is charged to a shift converter with steam where CO is converted to CO_2 with accompanying production of H_2 (mol H_2 for mol CO_2.) CO_2 is removed by methanolamine absorbtion after conversion. Final clean up of CO_2 is effected with a caustic wash. Remaining

Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1, 2, 3*) are for other firms willing to provide services for the process.

impurities in the hydrogen stream (CO and CH_4) are removed by condensation with liquid nitrogen in a low temperature unit. Hydrogen of 97+% purity at 250 psig is obtainable from the unit.

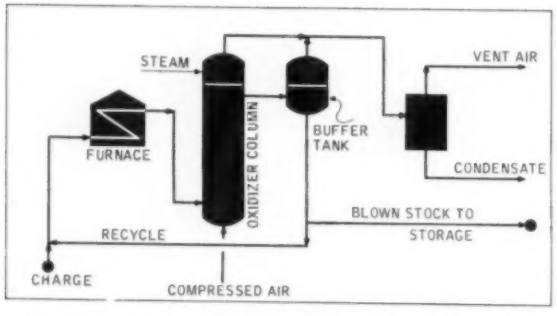
The process is licensed by Texaco Development Corp. under patent rights of The Texas Co. and Hydrocarbon Research, Inc.

Partial oxidation process references include:

(1) Duff, Barrett S., "Ammonia—Cost of Manufacturing from Five Different Raw Materials," PETROLEUM PROCESSING, Feb. 1955, pp. 223-228
(2) Eastman, duBois, "Synthesis Gas by Partial Oxidation," *Ind & Engrg. Chem.* July, 1956, pp. 1118-22
(3) Eastman, duBois, "Production of Synthesis Gas by Partial Oxidation," Div. Gas & Fuel Chem. Symposium, Minneapolis, Sept, 1956, Synthetic Fuels & Chemicals, No. 35-5., pp. 71-80
(4) Reidel, J. C., "A First: Hydrogen by Partial Oxidation," *Oil & Gas J.*, June 7, 1954, pp. 86-91

MISCELLANEOUS

Asphalt Manufacture



Two general types of petroleum asphalts are produced: (1) residual, those produced by vacuum distillation, steam distillation or propane deasphalting of a suitable cut from asphalt base crude and (2) air blown, those made by oxidation of asphalt base reduced crude.

For the manufacture of paving asphalt, two grades of residue can be produced (one soft and one hard) by distillation. Blending the two grades, along with lighter components, will meet a whole series of paving asphalt specifications.

Air blowing may be either a continuous or a batch process. Oxidation catalysts such as ferric chloride and phosphorus pentoxide are used to impart special characteristics and reduce blowing time.

In the continuous process, asphaltic residue from the vacuum tower is fed to the bottom of a column. Air is introduced at the tower bottom at 400-600°F with a rate of 30-50 cu ft/minute/ton of charge. The reaction is exothermic, and steam is often introduced to control the temperature and slow down the process. The amount of air contact and recycle is adjusted to produce the desired hardness. Oxidized asphalt overflows the top of the column to a tank from which withdrawal is made for both storage and recycle. Most roofing asphalts are produced by air blowing.

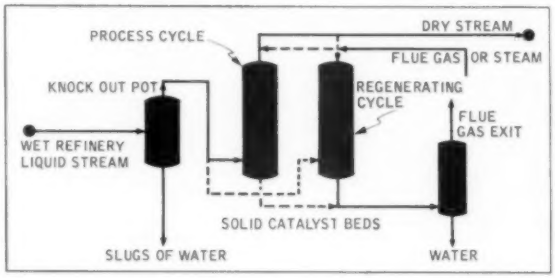
Whether an asphalt is prepared by distillation or oxidation depends upon specifications desired.

Literature references include:

(1) Abraham, H., *Asphalts and Allied Substances*. Fifth Edition, New York, D. Van Nostrand Co., 1945
(2) Egloff, G. and J. C. Morrell, "Asphalt from the Cracking Process," *Ind. & Engrg. Chem.*, June 1931, pp. 679-680
(3) Fan, Yun-Nan, "Why Is Continuous Asphalt Best?" PETROLEUM PROCESSING, June 1955, pp. 862-864
(4) Guthrie, V. B., and W. A. Bussard, "Surge Ahead for Asphalt," PETROLEUM PROCESSING, Jan. 1957, pp. 39-44
(5) Kastens, M. L., "Paving Asphalt from California Crude Oil," *Ind. & Engrg. Chem.*, Apr. 1948, pp. 548-557
(6) Kirschbraun, Lester, "Asphalt Emulsion Has Many Uses in the Chemical Plant," *Chem. Met. Engrg.*, Aug. 1929, pp. 477-479
(7) Lomax, E. L., "Qaeyarah Asphalt Plant Begins Operation in Iraq," *World Pet.*, Aug. 1955, pp. 41-43
(8) Milburn, H. M., and J. T. Pauls, "Types of Road Oils and Their Use in Road Building," *Nat. Pet. News*, July 11, 1934, pp. 28-36
(9) Mullins, G. M., "Road Oils," *Nat. Pet. News*, Aug. 10, 1932, pp. 25-30
(10) PETROLEUM PROCESSING, "Modern Asphalt Refinery Can Be Neat and Trim," Mar. 1952, p. 332
(11) *Ref. & Nat. Gaso. Mfr.*, "Vacuum Recovery of Penetration Asphalt," Apr. 1942, p. 78
(12) Shearon, W. H., "Catalytic Asphalt," *Ind. & Engrg. Chem.*, Oct. 1953, pp. 2122-2132

Available engineering services for Asphalt Manufacture:
PROC DESIGN: 3, *6*, 8, *11*, 17, 22, 23, *25*, 29, *32*, 36, 38, *40*, 46, 47, *48*, 49, 52, 56, 58, 60, 62, *66*, 70, 72, 75
MECH ENGRG: 3, *6*, 7, 8, *11*, 17, 22, 23, *25*, 36, 38, *39*, *40*, 46, 47, *48*, 49, 51, 52, 56, 58, *62*, *66*, 70, 72
CONSTR: 3, *6*, 8, *11*, 17, 22, 23, *25*, 29, *32*, 36, 38, *39*, *40*, 46, 47, *48*, 49, 52, 56, 58, 61, *62*, *66*, 70, 72

Gas & Liquid Drying



Water vapor removal from gases is achieved by compression, cooling, and refrigeration; by contact with hygroscopic chemicals such as flake caustic or calcium chloride, etc; or by absorbtion of water into diethylene glycol (see H_2S removal).

Water is removed from refinery liquids to reduce corrosion, prevent loss of water soluble additives, etc, and may be accomplished by contact with chemicals such as rock salt, calcium sulfate, etc.

The use of anhydrous catalysts in the refinery often requires drying of both gases and liquids and methods common to both include the use of clays (fuller's earth), activated alumina, and others. Solid adsorbents may be regenerated by blowing the bed with steam or hot flue gas. (300-400° F).

Generally two or more catalyst beds are used alternately in a drying and regeneration cycle. With liquid streams, a settler is provided to separate slugs of water prior to passage through the drying chamber. Gas streams containing alkaline or cracked material will cause plugging and if hydrogen sulfide is present, free sulfur may be deposited.

Literature references include:

(1) Capell, R. G. & R. C. Amero, "Dehydration Liquids and Gases with Granular Adsorbents," *Oil & Gas J.*, June 18, 1942, p. 37
(2) Daugherty, R. A., "A New Way to Dehydrate Gas," *Pet. Engr.*, Sept. 1956, pp. E13-16
(3) Nelson, W. L., "Drying Liquids with Adsorbents," *Oil & Gas J.*, June 1, 1946, p. 72
(4) Nelson, W. L., "Drying Natural Gas with Adsorbents," *Oil & Gas J.*, Mar. 30, 1946, p. 273
(5) PETROLEUM PROCESSING, "Temperature Required for Dryer Regeneration," July 1950, p. 747
(6) Senatoroff, N. K. "Application of Diethylene Glycol-Water Solution for Dehydration of Natural Gas," *Oil & Gas J.*, Dec. 15, 1945, p. 98

Available Engineering services for Drying of Gases are:
PROC DESIGN: 5, 6, 8, 11, 15, 17, 22, 23, 24, 25, 27, 29, 36, 38, *40*, 47, *48*, 49, 52, 56, 58, 62, *66*, 70, 72, 73, 75
MECH ENGRG: 6, 8, 11, 15, 17, 21, 22, 23, 24, 25, 27, 36, 38, *39*, *40*, 47, *48*, 49, 52, 56, 58, 62, *66*, 70, 72, 73
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Available Engineering Services

Many of these process descriptions include listings of engineering services available—process design, mechanical engineering, construction. The numerals with each listing refer to the directory of "Engineering and Other Service Firms," pp. 150-152, this issue. Regular numerals (1, 2, 3) are for firms reporting actual experience with the process; italic numerals (*1*, *2*, *3*) are for other firms willing to provide services for the process.

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Who's Who in Refinery Service Firms

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- *Licensing*
- *Process design*
- *Mechanical engineering*
- *Construction*

Comprehensive information about engineering and other firms serving refiners, compiled by Petroleum Processing.

Specific services from these firms are listed with descriptions in the Process Glossary, pp. 97-150.

ARMISTEAD & CO, GEORGE E-1
1200-18 St, NW, Washington 6, D C; ph REpublic 7-1580. George Armistead, Jr, Proprietor. Branch engrg office, Tamion Bldg, Athens, Greece. Broad advis & consult services with some process design.

ATLANTIC REFINING CO, THE E-2
2700 Passyunk Ave, Philadelphia 1, Pa; ph HOward 5-2345. J. A. Nevison, mgr, Licensing Sect, R&D Dept. Licenses own Catforming, Pentafining processes, and Union Cobalt Moly Desulf, Union Unifining, Nitrobenzene Lube Extr.

BADGER MANUFACTURING CO E-3
230 Bent St, Cambridge 41, Mass; ph UN 4-9800. W. C. Rousseau, VP-sales. Sales offices, 60 E. 42nd St, New York 17, NY; 2712 Danville St, Houston 6, Tex. Advis, consult, constr, proc design & mech engrg. Licenses SO_2 extraction of aromatics, lubes, gas oils; Ultrafractionation.

BECHTEL CORP E-4
220 Bush St, San Francisco 4, Calif; ph DOuglas 2-4032. C. T. Draney, VP. Branch engrg office, 4620 Seville Ave, Vernon, Calif. Branch sales offices, 485 Lexington Ave, New York 17, NY; 1300 Main St, Houston 2, Tex. Subsids, Bechtel Associates, 485 Lexington Ave, New York 17, NY; Canadian Bechtel Ltd, 25 King St W, Toronto, Ont, Canada. Contact company for services available.

BECHTOLD, IRA C, Consultant E-5
1987 Skyline Vista Dr, La Habra, Calif; ph OWen 7-4009. Advis, consult, process design for some cat, treat & dist processes.

BLAW-KNOX CO, CHEMICAL PLANTS DIV E-6
300-6th Ave, Pittsburgh 22, Pa; ph Express 1-1244. C. F. Hauck, VP-Sales. Branch engrg office (Midwest Hq), 180 N Wabash Ave, Chicago, Ill. Branch sales offices, Brown-Marx Bldg, Birmingham, Ala; 1000 Vermont Ave NW, Washington, DC; 180 N Wabash Ave, Chicago, Ill; Chrysler Bldg, 405 Lexington Ave, New York 17, NY; 931 Suburban Station Bldg, Philadelphia, Pa. Broad advis, consult, constr, process design & mech engrg services. Also has arrangements to license some cat reforming, hydrogen processing & mfg, isom, and Blaw-Knox decarbonizing.

BOVAY, H E, JR, ... E-7
5009 Caroline St, Houston 4, Tex; ph JA 9-4921. Branch engrg offices, 933 W 3rd St, Spokane, Wash; 1742 N 21st St, Baton Rouge, La. Advis, consult, mech engrg for cat, treat & dist processes.

BRAUN & CO, C F E-8
1000 Fremont Ave, Alhambra, Calif; ph ATlantic 2-1131 & CUmberland 3-1131. R. V. Peaslee, VP-sales. Branch sales offices, 45 Rockefeller Plaza, New York 20, NY; City Natl Bank Bldg, Houston, Tex; Russ Bldg, San Francisco 4, Calif. Subsids, C. F. Braun & Co of Canada Ltd; Braun International Corp. Broad advis, consult, constr, process design, mech engrg services. Working arrangements with many process licensors in U.S. and abroad, but does not engage in licensing or process promotion.

BROWN & ROOT, INC E-9
PO Box 3, Houston 1, Tex; ph FAirfax 3-7121. F. W. Bell, mgr Petrol & Chem Div. Branch sales offices, 4100 Clinton Dr, Houston, Tex; 1 Wall St, New York, NY; 307 Fourth St SW, Calgary, Alta, Canada; PO Box 4140, S Sta, Edmonton, Alta, Canada. Subsid, Brown & Root, Ltd. (engrg office at Calgary, Alta). Contact company for services offered.

CALIFORNIA RESEARCH CORP E-10
200 Bush St, San Francisco 4, Calif; ph Sutter 1-7700. R. L. Humphreys, mgr Invention Development. Parent, Standard Oil Co (Calif). Licenses own processes in alky, Calif poly. Cyclic Adsorption aromatics recov.

CATALYTIC CONSTRUCTION CO E-11
1528 Walnut St, Philalelphia 2, Pa; ph KI 5-7500. A. W. Krickl, asst to Pres. Branch engrg offices, 600 Vidal St S, Sarnia, Ontario, Canada; 900 Yonge St, Toronto, Ontario, Canada. Branch sales offices, 1810 Oakdale Ave, Toledo, Ohio; 1755 S Quincy St, Tulsa, Okla; 430 Marien Ave, Montreal, Quebec, Canada. Parent, Houdry Process Corp. Subsid, Catalytic Construction Co of Canada Ltd (engrg office at Sarnia, Ontario & Toronto, Ontario, Canada). Broad constr, process design, mech engrg services with advis & consult services for licensed Houdry processes.

CHEMICAL CONSTRUCTION CORP E-12
525 W 43 St, New York 36, NY; ph LOngacre 4-9400. S. Strelzoff, genl sales mgr. Constr, process design, licenses, R&D for hydrogen manuf and sulfur recov.

DAY & ZIMMERMANN, INC E-13
1700 Sansom St, Philadelphia 3, Pa; ph LOcust 4-4141. J. D. Johnson, Jr, engrg mgr. Branch sales offices, 500-5th Ave, New York 36, NY; 231 S LaSalle St, Chicago 4, Ill. Constr, process design, mech engrg on cat, solv rfg & treating processes.

DELTA ENGINEERING CORP E-14
2121 San Filipe Rd, Houston 19, Tex; ph Jackson 8-2411. G. L. Gudenrath, Pres. Subsid, Construction Service Co. Advis, consult, process design, mech engrg primarily for cat reform and treating processes.

DRESSER ENGINEERING CO E-15
PO Box 2518, Tulsa 1, Okla; ph LUther 7-2411. C. A. Core, VP. Advis, consult, constr, process design, mech engrg—primarily treating processes.

EBASCO SERVICES, INC E-16
2 Rector St, New York 6, NY; ph Digby 4-4400. C. A. Eastman, representative. Branch offices, 209 S LaSalle St, Chicago 4, Ill; 204 Southland Life Bldg, Dallas 1, Tex; 611 Equitable Bldg, Portland 4, Ore; 1625 Eye St, NW, Washington 6, DC; 120 Montgomery St, San Francisco 4, Calif. Otters engrg, constr and business services. Includes appraisal, consult, financial studies, industrial relations, insurance, pensions & safety, purchasing, inspection & expediting, rates & pricing, research, sales & public relations, systems, methods & budgets, taxes.

EHRHART & ASSOCIATES, INC E-17
417 S Hill St, Los Angeles 13, Calif; ph Madison 6-5371. W. L. Luzan, Sales Mgr. Branch engrg & sales office, 444 Market St, San Francisco 11, Calif. Broad availability for constr, process design & mech engrg, with experience in distillation & light hydrocarbon processes.

ESSO RESEARCH & ENGINEERING CO E-18
15 W 51st St, New York 19, NY; ph PLaza 7-3000. P. H. Holt, 2nd, mgr, Process licensing. Parent, Standard Oil Co (NJ). Licenses for Fluid Cat Crack, Suspensoid, Cat Combin Unit, Fluid Hydroforming, Powerforming, Hydrofining, Sulf Acid Alky, Fluid Coking, Lube Rfg (Phenol Extr, Propane Deasphalt & Dewax), Propane Deasphalt & Dewax of Gas Oils, Butadiene Extr.

FERGUSON CO, THE H K E-19
Ferguson Bldg, Cleveland 14, Ohio; ph TOwer 1-6400. E. D. Hoekstra, Dir of Pub Rel. Branch engrg offices, Equitable Life Bldg, San Francisco 4, Calif; Socony Bldg, New York 17, NY; Cooper and Wyoming Aves. (Cincinnati) Lockland, Ohio; Brown International Airport, Ft. Lauderdale, Fla. Branch sales offices, 1 N LaSalle St, Chicago, Ill; Fulton Natl Bank Bldg, Atlanta 3, Ga. Parent, Morrison-Knudson Co, Inc. Subsids, H. K. Ferguson Co of Canada Ltd; H. K. Ferguson Co of Great Britain Ltd. Constr, mech engrg for cat reforming and hydrogen processing & mfg with some advis and consult.

FILTROL CORP E-20
3250 E Washington Blvd, Los Angeles 23, Calif; ph ANgelus 3-5111. R. M. Haney, VP. Advis & consult for Contin Contract Filtration (clay treat) process.

FISH ENGINEERING CORP E-21
796 M & M Bldg, Houston, Tex; ph CA 5-5311. C. B. Ames, Pres. Subsids, Fish Northwest Constructors; Fish Service Corp. Constr; mech engrg for some cat crack, cat reform, alky, thermal, treating, dist processes. Advis, consult, constr, mech engrg, licensing for light hydrocarbon processes.

FLUOR CORP, LTD, THE E-22
2500 S Atlantic Blvd, Los Angeles 22, Calif; ph ANgelus 2-6111. J. P. Kneubuhl, VP-sales. Branch engrg offices, 3137 Old Spanish Trail, Houston 21, Tex; Graybar Bldg, 420 Lexington Ave, New York 17, NY; 1259 Dorchester Rd, Niagara Falls, Ont, Canada. Branch sales offices, 1594 The Houston Club Bldg, Houston, Tex; 589-5th Ave, 17th Floor, New York 17, NY; P. C. McKenzie Co, PO Box 10396, Pittsburgh 34, Pa. Subsids, The Fluor Corp of Canada, Ltd; Fluor Maintenance, Inc. Affils, H. G. Acres & Co. Ltd; Singmaster & Breyer, Inc Division (of Fluor Products Co), Santa Fe Tank & Tower. Broad constr, process design, mech engrg and licensing services.

FOSTER WHEELER CORP E-23
165 Broadway, New York 6, NY; ph WOrth 4-4400. W. L. Mortwick, VP in chge of sales. Branch engrg offices, 255 Huntington Ave, Boston 16, Mass; 333 N Broad St, Elizabeth, NJ; 6300 Bowling Green, Houston 21, Tex. Branch sales offices, W. D. Taulman & Assoc, PO Box 436, Northside Branch, Atlanta 5, Ga; 80 Federal St, Boston 10, Mass; 105 W Adams St, Chicago 3, Ill; Leader Bldg, Cleveland 14, Ohio; 505 N Ervay St, Dallas 1, Tex; Michigan Bldg, Detroit 26, Mich; 711 Main St, Houston 2, Tex; Dwight Bldg, Kansas City 7, Mo; 714 W Olympic Blvd, Los Angeles 15, Calif; Packard Bldg, Philadelphia 2, Pa; Oliver Bldg, Pittsburgh 22, Pa; 36 Winthrop St, Rochester 7, NY; 461 Market St, San Francisco 5, Calif; Tower Bldg, Washington 5, DC. Subsids, Foster Wheeler Ltd, London, England; Foster Wheeler Ltd at Edmonton, Halifax, Montreal, Toronto, Vancouver & Winnipeg, Canada; Societe Foster Wheeler Francaise, Paris, France; General Regulator Corp, New York, NY. Broad advis, consult, constr, process design, mech engrg & some R&D.

GASOLINE PLANT CONSTRUCTION CORP E-24
253 Esperson Bldg, Houston 2, Tex; ph CApitol 2-0302. M. H. Kotzebue, Pres. Constr, process design & mech engrg for light hydrocarbons.

GILL, J B, DIV OF PAUL HARDEMAN, INC E-25
11558 Tennessee Ave, Los Angeles 64, Calif; ph BRadshaw 2-7861 & GRanite 7-6761. F. T. Campo, VP; P. R. Black, mgr-engrg; D. V. Flint, chf proc engr. Branch sales offices, 611 Oskell St, Bakersfield, Calif; 1445 W Quincy, Englewood, Colo; Aparatado del Este 4575 Caracas, Venezuela, SA. Broad availability for advis, consult, constr, process design & mech engrg.

GIRDLER CO, THE E-26
Louisville 1, Ky; ph JU 7-7551. L. E. Osmer, sales mgr. Branch sales offices, 235 Montgomery St, San Francisco, Calif; 150 Broadway, New York 38, NY. Parent, National Cylinder Gas Co. Subsid, Girdler Corp of Canada Ltd. Constr, process design for Hygirtol & Girbotol sulfur removal.

GRAFF ENGINEERING CORP E-27
413 Meadows Bldg, Dallas 6, Tex; ph Emerson 8-3760. R. A. Graff, Pres. Affil, International Process Equip Corp, Dallas, Tex. Advis, consult, constr, process design, mech engrg and R&D for sulfur removal & light hydrocarbons.

GRAVER CONSTRUCTION CO, INC E-28
424 Madison Ave, New York 17, NY; ph MUrray hill 8-6149. S. D. Barr, genl sales mgr. Div & sales offices at PO Box 1165, Joliet, Ill; PO Box 1764, Houston, Tex; PO Box 308, Wilmington, Del. Parent, Graver Tank & Mfg Co, Inc. Broad constr services.

GREBE & DOREMUS PROCESS CO E-29
4601 Stanford, Houston 6, Tex; ph JA 2-5171. H. W. Temple, Jr, chf engr. Subsid, Grebe & Doremus Process Co Ltd. Advis, consult, constr & process design.

GULF RESEARCH & DEVELOPMENT CO E-30
Gulf Bldg, Pittsburgh 30, Pa; Dr C. W. Montgomery. Parent, Gulf Oil Corp. Advis, consult, licenses, R&D for Gulf HDS (M. W. Kellogg primary licensing activity) and Polyform (patents assigned to Gulf Oil Corp).

HEDRICK ENGINEERING CORP, WYATT C E-31
Box 1133, Houston 1, Tex; ph JA 3-4451. G. M. McGranahan, Pres; D. N. McClanahan, VP; P. Hall, Admin VP. Some advis, consult, constr & mech engrg.

HINDS, J C, RFY ENGRG SERVICE E-32
1415 W Ave H, Temple, Tex; ph Prospect 3-5882. J. C. Hinds, owner. Branch engrg office, 408 E Ute, Farmington, NM, ph Davis 5-9130. Advis, consult, constr & process design for cat, therm, treat & dist processes.

HOLMES & NARVER, INC E-33
828 S Figueroa, Los Angeles 17, Calif; ph TR 8201. C. B. Roen, mgr, Petro-Chem Div. Branch sales office, 1737 H St NW, Washington, DC. Primarily process design for cat crack, cat reform, hydrogen, isom, alky & poly processes.

HOUDRY PROCESS CORP E-34
1528 Walnut St, Philadelphia 2, Pa; ph PEnnypacker 5-9490. R. E. Bland, mgr, proc sales, H. D. Noll, dir, foreign opers. Subsids, The Catalytic Construction Co; Catalytic Construction of Canada Ltd. Advis, consult, process design, mech engrg, licenses and R&D for Houdriflow, Houdresid, Houdry Fixed-Bed Crack, Houdriforming, Iso-Plus, Cat Dehydrog, Hydrocrack, Hydropretreat, Houdrisom, Therm Crack of Cat Reformate, Therm Reform, Arosorb. Also some constr services.

HOWE-BAKER ENGINEERS, INC E-35
503 Bank of the Southwest Bldg, Houston 2, Tex; ph FAirfax 3-9125. C. H. Black & R. J. Phillips, VP's; Eastern Div (engrg & sales office), 35 Leonard Dr, Westwood, NJ, F. Lee, mgr. Advis, consult, constr, process design mech engrg, licenses, R&D for sulf acid treat; Electric Desalt, Desulf, Distillate Treating. Services without licenses for other treating processes.

HUDSON ENGINEERING CORP E-36
Box 6158, Fairview Sta, Houston 6, Tex; ph JA 9-4261. J. B. Baird, Exec VP. Branch sales offices, 2500 W 6th St, Los Angeles 57, Calif; 405 Lexington Ave, New York 17, NY; Corrientes 1115, Buenos Aires, Argentina; 4 Square Rapp, Paris 7, France. Broad constr, process design, mech engrg available with advis, consult, R&D for treat & dist processes (licensing for light hydrocarbon dist).

HUSKY OIL CO E-37
Box 380, Cody, Wyo; ph 500. K. E. Dyer, mgr of rfg. Advis, consult, process design, licenses and R&D for Diesulforming.

HYDROCARBON RESEARCH, INC E-38
115 Bdwy, New York 6, NY; ph Digby 9-1480. W. J. Norton, mgr, Contracts Div, Branch engrg offices, Hydrocarbon Mineraloel GmbH, 25 Furstenwall, Duesseldorf, Germany; Hydrocarbon Engrg, SARL, 44 Ave des Champs Elysees, Paris 8e, France. Branch sales offices, Hyrdocarbon Research, Lopez 15, Mexico 1, DF; General Heitor Pedroso, Rua la Quitanda 20, Sala 801, Rio de Janeiro, Brazil. Broad advis, consult, constr, process design, and mech engrg services.

KAIGHIN & HUGHES, INC E-39
Atlantic & Spencer Sts. Toledo 9, Ohio; ph Walbridge 5671. A. Abboud, mgr-Chem & Rfy Div. Branch engrg & sales offices, 1417 E Archwood St, Akron, Ohio. Branch engrg office, 726 Stanton St, Toledo 4, Ohio. Subsids, K&H Engineering Co, Trugas Constructors, Inc. Primarily consult and mech engrg for piping and offsite facil, but avail for all refinery processes.

KAISER ENGINEERS DIV, H. J. KAISER CO E-40
1924 Broadway, Oakland 12, Calif; ph TWinoaks 3-4600. R. M. Cornforth, mgr rfy sales. Branch sales offices, 300 Park Ave, New York 22, NY; 1625 "I" St, NW, Washington, DC; 330 Grant St, Pittsburgh 12, Pa. Parent, Henry J. Kaiser Co, with other subsids—Henry J. Kaiser Co (Canada) Ltd; Kaiser Engineers International, Inc; Kaiser Engineers Overseas Corp. Broad advis, consult, constr, process design, mech engrg services.

KELLOGG CO, THE M. W. E-41
711-3rd Ave, New York 17, NY; ph OXford 7-5200. R. J. Wolfe, VP-sales; J. M. McAneny, Admin Sales Mgr; M. J. Carnesale, Eastern Div Sales Mgr. Branch sales offices, 1407 Russ Bldg, San Francisco 4, Calif (W. R. Dunn); 504 Phil-tower Bldg, Tulsa 3 Okla (P. Hughes); 453 Esperson Bldg, Houston 2, Tex (W. T. McCay). Parent, Pullman, Inc. Subsids, The Canadian Kellogg Co Ltd (Toronto); Kellogg International Corp (London); Companhia Kellogg Brasileira (Rio De Janeiro); Compania Kellogg de Venezuela (Caracas); Kellogg Pan American Corp (New York); Societe Kellogg (Paris). Broad advis, consult preliminary planning, constr, process engrg design & mech engrg, licensing, R&D, procurement, operator training, & model making for individual processes or complete refineries. Contact company for further information.

KIDDE ENGINEERS-SOUTHWEST, INC, WALTER E-42
PO Box 8347, Houston, Tex; ph JAckson 9-2644. C. McCormick, asst genl mgr. Branch engrg office, 811 Louisiana Ntl Bank Bldg, Baton Rouge, La. Parent, Walter Kidde Constructors, Inc. Advis, consult, constr, process design & mech engrg on therm, solv & treating processes.

KOPPERS CO, INC E-43
Koppers Bldg, Pittsburgh 19, Pa; ph Express 1-3300. W. C. Rueckel, VP-engrg & constr div. Branch sales office, 430 Park Ave, New York 22, NY. Advis, consult, constr, process design, mech engrg and R&D for hydrodesulf, hydrog, thermal, solv rfg, treating & dist processes.

LINDE AIR PRODUCTS CO E-44
30 E 42nd St, New York 17, ph MUrray Hill 7-8000. A division of Union Carbide & Carbon Corp. Licenses Copper Sweetening process.

LITTLE, INC, ARTHUR D E-45
30 Memorial Dr, Cambridge 42, Mass; ph UNiversity 4-9370. Alexander Bogrow. Branch labs, 9 S Clinton St, Chicago, Ill; 235 Montgomery St, San Francisco, Calif; Edinburgh, Scotland. Regional offices, 420 Lexington Ave, New York, NY; 727 W 7th St, Los Angeles, Calif; 1625 Eye St NW, Washington, DC. Services in operations research, studies of supply & demand, petrochemicals diversification, refinery locations, new products from refinery streams.

LITWIN ENGINEERING CO E-46
204 N Waco, Wichita, Kans; ph Amherst 5-9543. Harry Litwin, Pres. Affil, Century Construction Co. Advisory, consult constr, process design, mech engrg for cat, therm, treating dist processes.

LUMMUS CO, THE E-47
385 Madison Ave, New York 17, NY; ph PLaza 9-1180. J. H. Curtis, VP. Branch engrg office, 2707 Weslayan Rd, Houston 6, Tex. Branch sales office, 600 S Michigan Blvd, Chicago 5, Ill. Subsids, The Lummus Co of

■ 1957 Refining Process Glossary

LUMMUS CO.—cont.
Canada Ltd; The Lummus Co Ltd, Societe Francaise des Techniques Lummus; Lummus Nederland NV; Compania Anonima Venezolana Lummus. Broad advis, consult, constr, process design, mech engrg services. R&D for many thermal, solv rfg, treating, & dist processes. License for Contin Contact Coking.

MACCO CORP **E-48**
14409 S Paramount Blvd, Paramount, Calif; ph NEvada 6-1261 & MEtcalf 3-1121. E. Van Dornick, VP. Branch sales office, Canadian Macco, Walkem & Walkem, 1501 Standard Bldg, Vancouver 2, BC, Canada. Subsids, Belyea Truck Co; Diversified Builders, Inc. Affil, Pacific Dredging Co. Divisions, Constr, Pacific Crane & Rigging, Rfy & Chem, Pipeline, Rig Bldg, Drilling Fluid, Lumber. Broad availability for advis, consult, constr, process design, mech engrg.

McKEE & CO, ARTHUR G **E-49**
2300 Chester Ave, Cleveland 1, Ohio; ph TOwer 1-2300. M. J. Livingston, VP. Branch engrg offices, 1080 Morris Ave, Union, N J; Room 400, Terminal Warehouse Bldg, Toronto, Ont, Canada. Sales offices, Room 4610, 30 Rockefeller Plaza, New York 20, N. Y; 372 Bay St, Room 1901, Toronto, Ont 1, Canada. Subsid, Arthur G. McKee & Co of Canada Ltd. Broad advis, consult, constr, process design & mech engrg services.

MEKLER, L. A., Consulting Engr **E-50**
525 Lexington Ave, New York 17, NY. Advis, consult, process design and R&D for cat & thermal processes, gas synthesis, shale dist & burning.

O'DONNELL, JAMES P **E-51**
39 Bdwy, New York 6, NY; ph DIgby 4-0404. James P. O'Donnell (New York), Chas. A. Knight (Beaumont), Joseph W. Moorman (Tulsa). Branch engrg offices, Bowie Bldg, Beaumont, Tex; Enterprise Bldg, Tulsa, Okla. Primarily mech engrg with some advis, consult & process design.

PARSONS CO, THE RALPH M **E-52**
617 S Olive St, Los Angeles 14, Calif; ph MAdison 9-2484. E. Layfield, VP; M. Lewis, Exec VP. Branch engrg offices, PO Box 3903, Karachi, Pakistan; 172 Golf Links Area, New Delhi, India; 151 S DeLacey Ave (Electronics Div), Pasadena, Calif; Parsons & Heurtey, 9 Arsene Houssaye, Paris, France; The Ralph M. Parsons Engrg Co, 252/2 Saadoon Park, Baghddad, Iraq; & c/o E. A. Juffali & Bros, PO Box 297, Jeddah, Saudi Arabia. The Ralph M. Parsons Constr Co, SA, Batman, Turkey. Branch sales offices, Room 803, 10 E 40th St, New York 16, NY; Suite 1125, 1001 Connecticut Ave, NW, Washington 6, DC; Serrano 21, Madrid, Spain; Lorstan Apt Bldg, Rue Al-Hamra, Beirut, Lebanon. The Ralph M. Parsons Constr Co, SA, Ataturk Bulvari 171/9, P.K. 1035 Yenisehir Branch, Ankara, Turkey. Broad advis, consult, constr, process design, mech engrg services.

PETRECO DIV, PETROLITE CORP **E-53**
PO Box 2546, Houston 1, Tex; ph WAlnut 6-7431. I. S. Boydstun, sales mgr. Branch engrg & sales office, 1390 E Burnett (Box 72161), Long Beach 7, Calif. Branch sales offices, 1514 Broadway, Toledo 9, Ohio; 150 E 42 St, New York 17, NY; 250 Elm St, Winnipeg 9, Manitoba, Canada. Parent, Petrolite Corp. Advis, consult, process design, mech engrg and R&D for treating processes. Licenses for Electric Dehydration, Electrofining Distillate Treating, Electric Removal (Arsenic, Nitrogen, Lead) & H_2S Removal.

PHILLIPS PETROLEUM CO **E-54**
Bartlesville, Okla; ph 6600. A. D. Fischbeck, mgr, Petro Div. Process design, licenses and some advis & consult for Cat Reform Feed Prep, Cat Isom, HF Alky, Pebble Heater Gas Crack, Acetylene Remov, Vac Dist, Cyclaversion & Cat Dehydrog. Also advis, consult & processs design on other cat & treating processes.

PODBIELNIAK, INC **E-55**
341 E Ohio St, Chicago 11, Ill; ph SUperior 7-7825. H. R. Kaiser, VP. Advis, consult, process design and constr for solv rfg & treating.

PONA ENGINEERS, INC **E-56**
PO Box 8217, Houston 4, Tex; ph CA 7-4173. C. S. Faulkner, Pres. Branch sales offices, 1419 Scarth St, Regina, Saskachewan, Canada; Salas a Caja de Agua No. 71, Caracas, Venezuela. Subsids, Pona Constructors, Inc; Pona Engineers Ltd (Canada). Broad availability for advis, consult, constr, process design, mech engrg services.

PRENGLE, DUKLER & CRUMP **E-57**
5417 Crawford St, Houston 4, Tex; ph CApitol 5-1691. General activities, some advis, consult, process design, mech engrg, and R&D.

PRITCHARD & CO, J. F. **E-58**
4625 Roanoke Pkwy, Kansas City 12, Mo; ph JEfferson 1-9500. H. A. Martin, Exec VP. Branch sales offices, 35 E Wacker Dr, Chicago 6, Ill; 405 Lexington Ave, New York 17, NY; 905 Union Trust Bldg, Pittsburgh 19, Pa; 2261 W Holcombe Blvd, Houston 5, Tex. Subsids, J. F. Pritchard & Co of Calif; Municipal Service Co (Kansas City, Mo); Poole Pritchard Ltd (Calgary, Alberta, Canada). Broad availability for constr, process design, mech engrg services.

PROCON, INC **E-59**
1111 Mt Prospect Rd, Des Plaines, Ill; ph NEwcastle 1-8200. J. R. Britt, mgr-chem plt sales; W. H. Grosse, mgr-rfy sales. Branch engrg office, 23 E Jackson Blvd, Chicago 4, Ill. Branch engrg & sales offices, 40 Advance Rd, Toronto 18, Ont, Canada; Bush House, Aldwych, London, W. C2, England. Parent, Universal Oil Products Co. Subsids, Procon (Great Britain) Ltd; Procon (Canada) Ltd; Procon International, SA. Broad constr & mech engrg services with advis, consult, process design on dist processes.

PURVIN & GERTZ, INC **E-60**
910 Fidelity Union Life Bldg, Dallas, Tex; ph Riverside 1-6776. M. H. Gertz, Exec VP. Advis, consult & some process design.

REFINERY CONSTRUCTION CO OF HOUSTON **E-61**
PO Box 6734, Houston 5, Tex; ph JAckson 8-4261. G. H. Zarafonitis, VP & genl mgr. Affils, Refinery Construction Co of South America; Petro-Chem Construction Co. Constr on cat, thermal, treating and dist processes.

REFINERY ENGINEERING CO (Treco) **E-62**
PO Box 1558, Tulsa, Okla; ph LUther 4-3461. H. V. Flemming, Jr, VP. Branch engrg & sales office (Refinery Engrg Ltd), PO Box 6, Terminal A, Toronto, Ont, Canada. Parent, Vitro Corp of America. Broad advis, consult, constr, process design, mech engrg.

RUSSELL ENGINEERING CORP **E-63**
PO Box 6731, Houston 5, Tex; ph MA 3-4423. G. F. Russell, Pres & chf engr. Branch engrg office, PO Box 549, Sterling, Colo. Process design and constr for light hydrocarbons.

SHELL DEVELOPMENT CO **E-64**
50 W 50th St, New York 20, NY; ph JUdson 6-5000. J. A. Horner, VP. Branch engrg office, 4560 Horton St, Emeryville 8, Calif. Parent, Shell Oil Co. Process design, licensing and R&D for 2-Stage Cat Crack, Trickle & Vapor-Phase Hydrodesulf, Diolefin & Diisobutylene Hydrog, Vapor-Pase & Liquid-Phase Isom, Cold Acid Isobutylene Poly, Extr Dist Aromatics Recovery, Solutizer & Steam Regen & Air Solutizer, Phosphate Desulf, Carbonyl Sulfide from C_3, Cat Dehydrog, Lithium 12-Hydroxystearate Grease.

SOLLITT CO, SUMNER **E-65**
307 N Michigan Ave, Chicago 1, Ill; ph State 2-4459. A. J. Barth, VP-engrg. Subsids, Sollitt Overseas Construction Co, Sumner Sollitt Co of Texas. Advis, consult, constr, process design, mech engrg and R&D for lubes & greases.

SOUTHWESTERN ENGINEERING CO **E-66**
4800 Santa Fe Ave, Los Angeles 58, Calif; ph LUdlow 3-6262. J. L. Baker, VP-Sales. EGC Div. Broad constr, process design, mech engrg services.

STANDARD OIL CO (IND) **E-67**
910 S Michigan Ave, Chicago 80, Ill; ph Harrison 7-9200. W. S. Nordburg, asst to mgr, Development & Patent Dept. Licensing and R&D for Ultraforming, Hydrodesulf, Isomate, Pentane & Butane Isom, HF Extr of Gas Oils & Urea Dewaxing.

STAPP ENGINEERING CORP, THE **E-68**
PO Box 7588, Denver 15, Colo; ph BElmont 3-4218. M. A. Stapp, Pres. Advis, consult for light hydrocarbons processes.

SUN OIL CO **E-69**
1608 Walnut St, Philadelphia 3, Pa; Kingsley 6-1600. Licenses own Hydrodesulf process.

Reprints Available

Reprints combining the Process Glossary and Engineering Firm Directory are available for $1.00. Check **R47** on the Reader Service Card, pp. 281-2.

STONE & WEBSTER ENGINEERING CORP **E-70**
90 Broad St, New York 4, NY; ph BOwling Green 9-4224; 49 Federal St, Boston 7, Mass; ph HAncock 6-2500. Contact nearest office. Branch sales offices, 609 S Grand Ave, Los Angeles 17, Calif; 235 Montgomery St, San Francisco 4, Calif; 33 S Clark St, Chicago 3, Ill; 850 Esperson Bldg, Houston 2, Tex. Parent, Stone & Webster, Inc. Subsids & affils, Stone & Webster Canada Ltd (Toronto); E. G. Badger & Sons Ltd (London, England); Establishments Badger SA (Paris, France). Broad advis, consult, constr, process design, mech engrg.

STRATFORD ENGINEERING CORP **E-71**
612 W 47th St, Kansas City 12, Mo; ph LOgan 1-5030. D. H. Putney, Pres. Sales reps, Lester Oberholtz Associates, 2500 W Sixth St, Los Angeles 57, Calif; Rawson & Co, 1223 Waugh Dr, Houston, Tex; D. D. Foster Co, 501 Alcoa Bldg, Pittsburgh 19, Pa. Advis, consult, process design, mech engrg, licenses and R&D for Effluent Refrig Alky, Sulf Acid Alky, Acid Treat of Lubes, Sulf Acid Treat. Services without license for lube, grease and soap processes.

TEARS ENGINEERS **E-72**
4617 Cole Ave, Dallas 5, Tex; ph LAkeside 6-7474. C. F. Tears, Pres. Branch sales office, 21 West St, New York, NY. Broad constr, process design, mech engrg services available.

TELLEPSEN PETRO-CHEM CONSTRUCTORS **E-73**
PO Box 2536, Houston 1, Tex; ph WA 3-9331. S. H. Wilde, Div sales mgr. Branch engrg & sales office, Apartado 419, Maracaibo, Venezuela. Branch sales offices, 1719 Florida St, Baton Rouge, La; 5 de Mayo Num. 32, 4° Piso, Mexico City 1, DF. Parent, Tellepsen Construction Co with other subsid, Tellepsen de Mexico, SA and affils, Trans-Caribbean, SA & The Chillgas Corp. Broad constr & mech engrg services with some advis, consult, constr, & process design.

TEXACO DEVELOPMENT CORP **E-74**
135 E 42nd St, New York 17, NY; ph MUrray Hill 9-7700. Advis, consult, licensing, R&D for Partial Oxidation Hydrogen Manuf, Furfural Rfg, MEK Dewax, MEK-Benzol Dewax, Solv Dewax, Wax Fractionation & Manuf. Also licenses & R&D for Sulf Acid Alky, with R&D for hydrotreating effluent refrig alky.

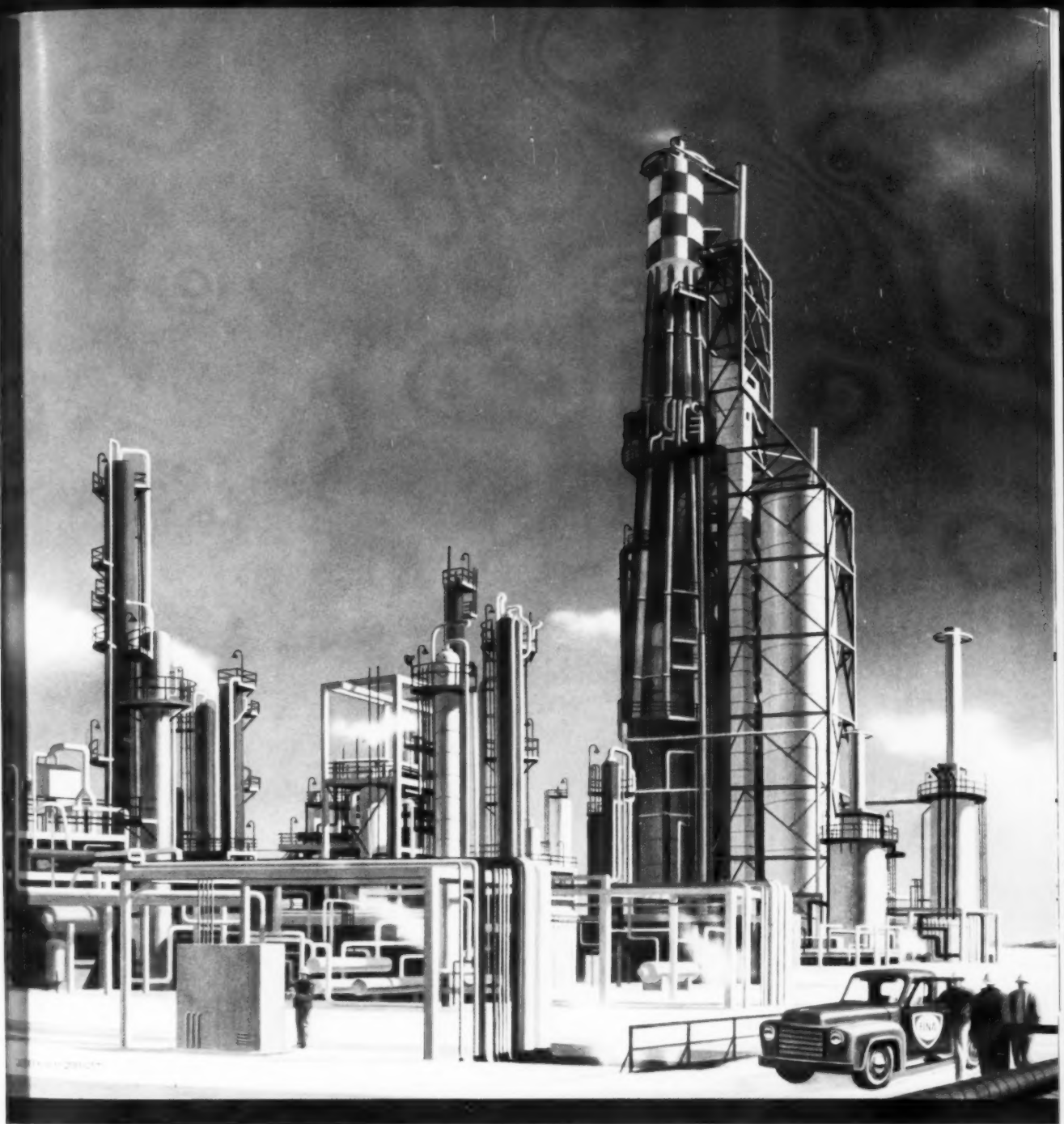
TEXAS CHEMICAL ENGINEERING CO **E-75**
4101 San Jacinto St, Houston 4, Tex; ph VA 4-2214. T. L. McNamara, Pres. Sales office, same address. Advis, consult, process design primarily for treating & dist. Licenses ADC Electrolytic Mercaptan & Ferrocyanide Treating.

TURNER CONSTRUCTION CO, C. A. **E-76**
1626 Bank of the Southwest Bldg, Houston, Tex. J. A. Boyer, VP. Branch engrg office, 3435—25th St, Port Arthur, Tex. Constr for cat, solv & treating processes.

UNION OIL CO OF CALIF **E-77**
617 W 7th St, Los Angeles 17, Calif; ph MAdison 9-3261. H. R. Emmerson, Commercial Development Div. Branch engrg & sales office at Union Oil Research Center, Brea, Calif. Advis, consult, process design, licenses, R&D for Union Unifining, Azeotropic Dist, Wax Manuf & Hypersorption, with R & D for Hyperforming.

UNIVERSAL OIL PRODUCTS CO **E-78**
30 Algonuin Rd, Des Plaines, Ill; ph (Chicago) ROdney 3-6000. Davis Read, mgr, Commercial Development Dept; W. W. Johnstone, mgr, Product Sales Dept. Subsid, Procon, Inc. Broad advis, consult, process design, mech engrg and R&D services with licenses for Fluid Cat Crack, Two-Stage Cat Crack, Platforming, Rexforming, Hydrobon Platreating, Unifining, Low Press Hydrog, Cobalt-Moly Desulf, Alum Chlor Isom, Penex, Alum Chlor Alky, HF Alky, Phos Acid Poly & Alky, Sulf Acid Alky, Therm Crack, Therm Reform, Arosorb, Udex, Unisol, Clay Treat, Inhibitor Sweetening, Cat Dehydrog, Fluid Cat Desulf. Also services in operator trng, process trouble-shooting, equip inspect & economic studies.

VULCAN-CINCINNATI, INC. **E-79**
120 Sycamore St, Cincinnati 2, Ohio; ph DUnbar 1-1400. W. D. Beers, asst mgr Vulcan Engrg Div; R. A. Menges, asst mgr, Vulcan Constr Div. Branch sales offices, Wm. Davis, 1115 Canterbury Rd, Charlotte, NC; C. P. Eldred, 24 Canterbury Rd, Winchester, Mass; M. T. Litton, 8614 Link Pass Lane, Houston 25, Tex; C. N. Fulcher, 24 California St, San Francisco, Calif; Horblit & Co, 2329 Champa St, Denver 5, Colo. Affil, Vickers-Vulcan Process Engineering Co Ltd, Montreal, Quebec, Canada. Broad availability for constr, with process design and mech engrg services for distillation and petrochemical processes.



CANADIAN PETROFINA LIMITED

The Houdriflow catalytic cracking unit at the new Montreal refinery of Canadian Petrofina Limited has a nominal design daily capacity of 16,000 barrels, comprising 10,500 barrels of fresh feed and 5,500 of recycle. The unit provides deep conversion of feed with high yields of high octane gasoline, light olefins and isobutane. Olefins and isobutane are converted by secondary processing to alkylate and cat poly gasoline. All Houdriflow cracking units are designed to permit the refiner to take advantage of the new Houdry Mineral Kaolin Catalyst.

For information about Houdry Processes and Catalysts, write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

HOUDRY

PROCESS CORPORATION

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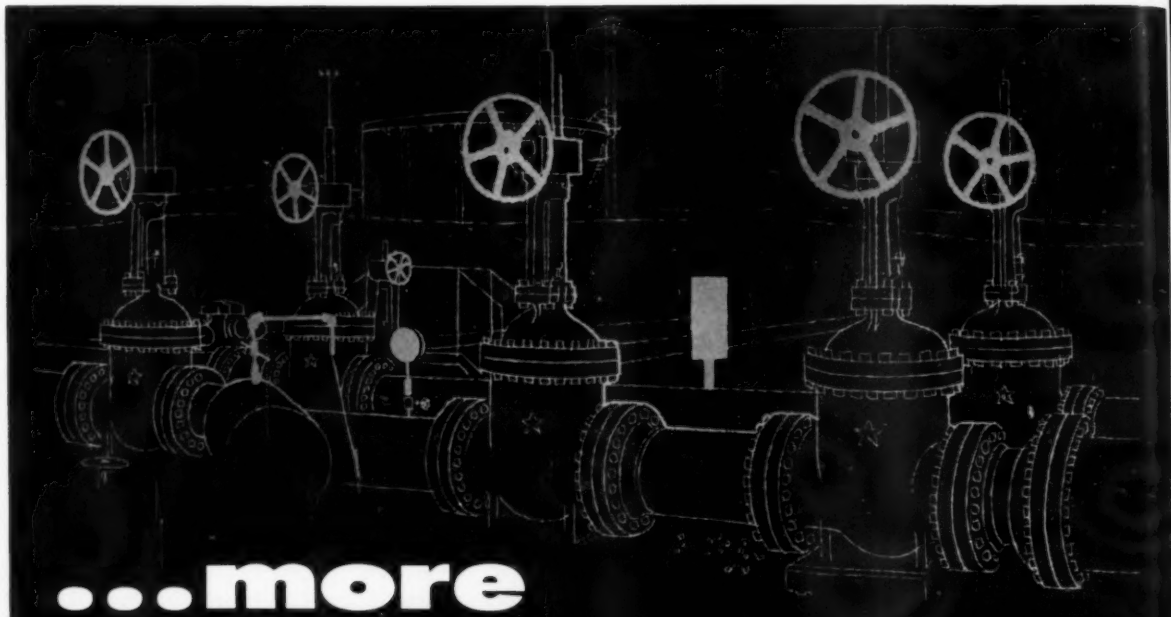

...more quality proved POWELL VALVES

Fig. 3059G—300-Pound Steel Lubricated Plug Valve. Bolted Gland type. Gear Operated. Sizes 6" to 12".

Fig. 2467—Small Stainless Steel Gate Valve for 300 Pounds W.P. Outside screw stem and bolted yoke.

Fig. 86190—Steel "LPG" Globe Valve for 400 W.O.G. For services that demand the use of Steel Valves.

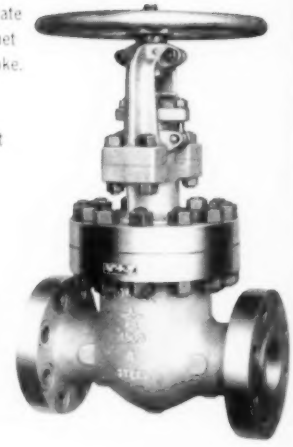

Fig. 1303—1500-Pound Steel Gate Valve with bolted flanged bonnet and outside screw stem and yoke.

made with quality proved materials

Consult your Powell Valve Distributor for full facts about quality proved bronze, iron, steel, and corrosion-resistant valves. For every flow control problem—there is a Powell Valve to solve it . . . *better.*

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR

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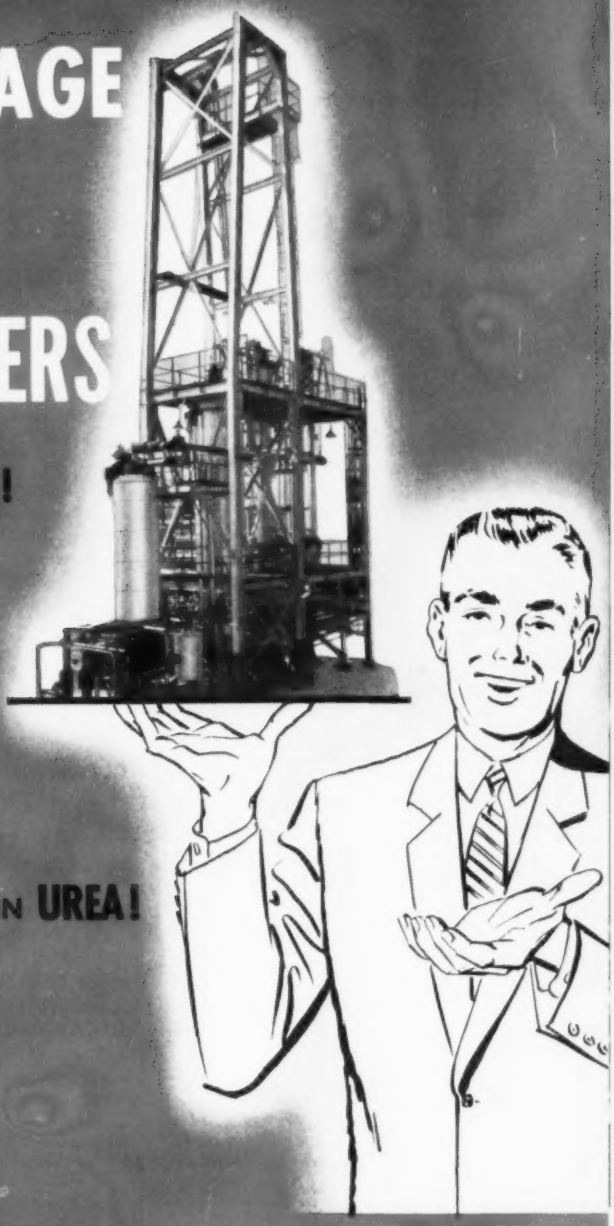
for

FERTILIZER PRODUCERS



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exhaustive tests prove:

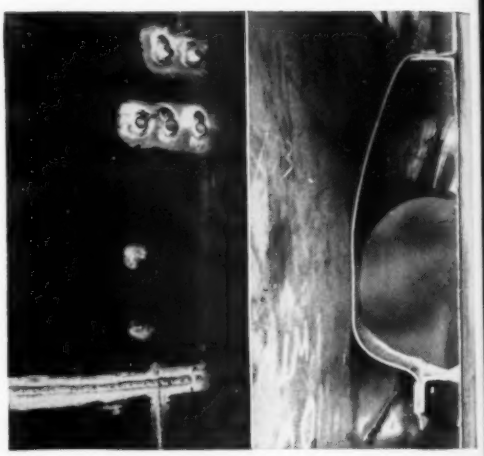
36 YEARS FROM TODAY

TUBESEALS* NOW IN FLOATING ROOF TANKS WILL OPERATE AS EFFICIENTLY AS THEY DO TODAY!

WE DOUBT this can be claimed for any other floating roof seal!

To determine the efficient life-expectancy of the Hammond Tubeseal in service, tests were made under the worst possible conditions to which a floating roof seal can be subjected. The Tubeseal was moved across very rough rivet heads, erection burrs and abrasive weld surfaces, for a total travel of 70,000 feet. This is equivalent to a normal wear of *more than 36 years in actual service.* Moreover, as the tests were run dry, there was the added disadvantage of the absence of lubricating effect normally created by wetted surfaces. Upon completion of these rigorous tests, the scuff band had only worn through the ribs and had barely penetrated through the material, leaving two-thirds of the stock intact; proof that the Tubeseal is unimpaired after traveling 70,000 feet.

The 36 year life-expectancy of a Hammond Tubeseal assumes no mechanical accident and is arrived at in the following manner: Each year a floating roof, in normal service, makes about 48 trips to and from top and bottom of tank. The roof of a 40 foot tank, therefore, will travel 1920 feet per year. Assuming 1920 feet of travel per year (based upon full depth of travel) and applying our accelerated wear test, the Tubeseal will be serviceable for at least 36 years 5½ months.



THE TUBESEAL TEST:

total travel	70,000 feet
travel over vertical weld	46,400 feet (on same line)
Horizontal welded seam crossed	21,200 times
Flat head rivets crossed	63,600 times

CONDITION OF TUBESEAL AFTER TEST- Scuff band had worn through ribs and had barely penetrated into the main material, leaving ⅔ of stock intact.

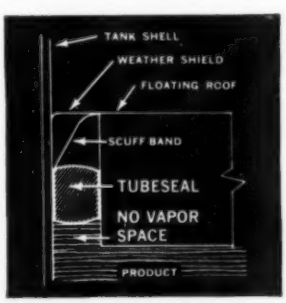
Tests were conducted dry with no aid of lubricant normally resulting from stored product.

Photos show projections used for test. Included are 16" of ⅜" horizontal weld—24" of sharp, irregular vertical weld—2 erection burrs—3 ¾" flat head rivets and 2 ¾" cone head rivets.

THE HAMMOND TUBESEAL
is the most efficient and positive seal known.

it features:

no moving parts
no mechanical maintenance
climate proof
non-corrodible
can operate to bottom of tank or above the top
no vapor space below the seal
entire circumference has tight seal under pressure at all times
longer working life expectancy



NO ROOM FOR VAPORS
NO EVAPORATION
NO CORROSION

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—Photograph courtesy of Standard Oil Company (N. J.)

How much can preheat raise throughput?

Today's soaring production costs spotlight the need for increasing throughput . . . that is, if slim profit margins are to be kept from disappearing altogether. A look at the Ljungstrom Air Preheater will show how this can be done.

Ljungstrom efficiency comes from the fact that preheated air mixes more thoroughly with fuel. This assures more complete combustion . . . higher flame temperature . . . and increased heat absorption into the tubes – which raises still throughput by as much as 25%!

For example, an eastern refinery went from 16,000 barrels to 18/20,000 barrels a day when the pipe still was modernized with a Ljungstrom system. In addition, temperature control was much closer. The octane rating of the product, because of this fine control, was held to narrower limits – *with the average rating as much as two octane numbers higher.*

How fast is "WRITE OFF"?

In earnings from increased output and improved quality, many refineries write off the cost of the Ljungstrom in less than 2 years. These costs can be written off sooner, in fact, when you add other Ljungstrom advantages: savings up to 20% in fuel costs . . . higher throughput . . . less slag . . . and use of fuels you used to discard.

For more complete data on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write the Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

don't waste steam

Nicholson steam traps have a powerful, intermittent valve action which closes the valve *completely*. Hardened stainless steel valve and seat are lapped and mated—there's no steam waste, no dribbling. And that's not all. With just one thermostatically-operated moving part, there's nothing to get out of order, nothing to go wrong. Nicholson means continuous and low-cost operation of your steam-using equipment . . . no downtime from trap failure.

- **high air-venting capacity . . . for faster warmup of equipment.**
- **small and lightweight . . . easy to pipe and support.**
- **each unit steam-tested before shipment.**

So, to get a trap that avoids waste, saves money, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. *Sales and Engineering offices in 98 principal cities.*

Write for Bulletin 1055

NICHOLSON
of Wilkes-Barre

LARGER SIZE RANGE

MIDWEST ELBOWS

IMPROVED DELIVERY

HEAVY WALL CARBON STEEL AND ALLOY

12" Long Radius
2¼" Wall Thickness
1¼% Chrome

20" x 10" Reducing
2" Wall Thickness
2¼% Cr—1% Mo.

STRAIGHT LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
36	1.250
30	2.000
26	2.000
24	1.500
20	1.375
18	2.250
16	2.125
14	1.750
12	2.000
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

These straight elbows can be furnished with LONG TANGENTS at no extra cost. All thicknesses less than those shown above are, of course, available.

The exclusive Midwest method of making all welding elbows from plate instead of tubing gives us a FLEXIBILITY OF MANUFACTURE that is much greater than by any other process. These heavy wall Midwest straight and reducing elbows are available in any material that can be secured as plate. The maximum wall thicknesses for which we now have equipment are indicated by the tables at left and right. And, because it is easier to get plate than tubing, better delivery is another advantage. Still another is the close tolerances inherent in our process.

Quality control goes beyond all code requirements. The longitudinal weld of every heavy wall elbow is completely X-rayed as standard procedure in our method of manufacture.

You will find it to your advantage to send us your inquiries.

REDUCING LONG RADIUS 90° ELLS

Nominal Pipe Size	Maximum Wall Thickness
30	2.000
26	*
24	2.000
20	2.000
18	2.000
16	1.500
14	1.750
12	2.250
10	2.000
8	1.750
6	1.000
5	.625
4	.750
3	.625
2½	.375
2	.500

Reductions to all nominal pipe sizes down to ½ large diameter. All thicknesses less than those shown above are, of course, available.
*Refer to factory.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo. • Plants: St. Louis, Clifton, N. J. and Los Angeles

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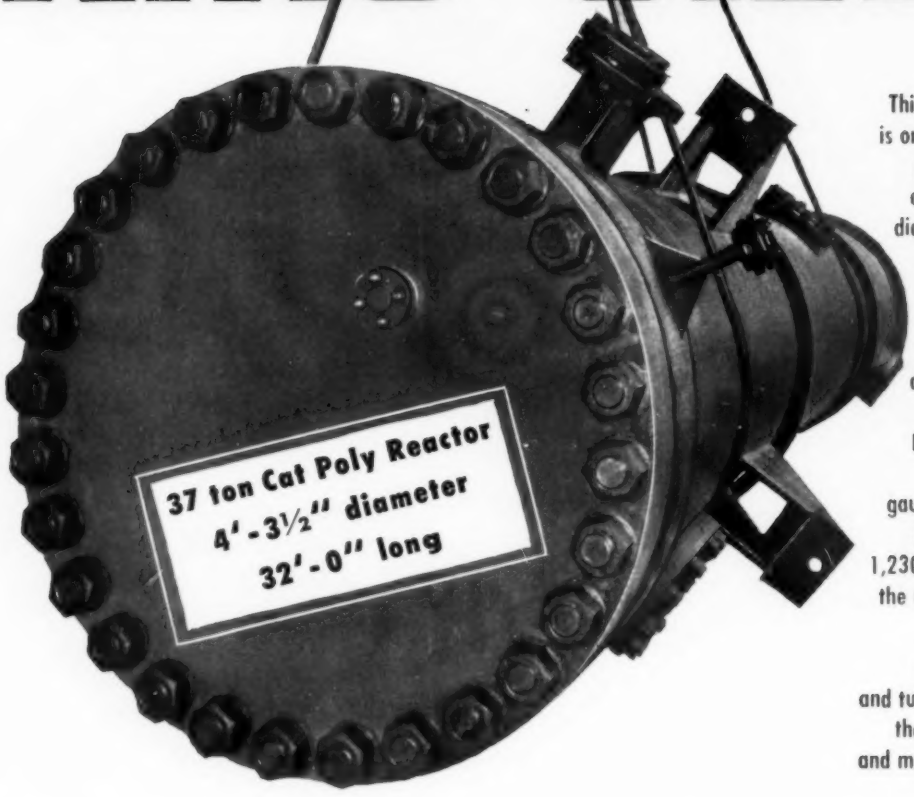
KING SIZE



This giant 37 ton Cat Poly Reactor is one of 4 units shipped to a large petroleum refinery in the State of Washington. It is 4'-3½" in diameter by 32'-0" long and has a 1 3/16" thick shell. Each of its 8" thick heads is attached to the shell channel with 28 special alloy stud bolts 2¾" diameter by 15¼" long having nuts 4¼" across the flats. Into the 5¾" thick tube sheets 190 tubes, 2½" O. D., No. 5 gauge and 30'-0" long, are rolled and seal welded. Designed for 1,230 lbs. pressure on the tube side, the reactor was completely X-rayed and stress relieved.

Vogt, a leading builder of shell and tube reactors for poly plants, has the competently skilled personnel and modern mechanical facilities with which to provide heat transfer equipment for the most exacting services in petroleum refineries, chemical plants, and related industries.

Reactors ...by Vogt

A bulletin describing the wide range of heat transfer equipment built by Vogt is available upon request.

Address
Dept. 24A-XPP

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Color Coat No. 261 adds lasting beauty to Insul-Mastic Gilsonite protective coatings.

NEW INSUL-MASTIC COLOR COAT No. 261 COVERS BLACKEST SURFACES . . .

solves these difficult finish problems . . .

ADHESION Color Coat No. 261 is the one finish that will stick to and cover black bituminous mastic coatings, old or new . . . as well as concrete, brick, cinder block, porous roofing tile, asbestos shingles, stucco—and properly primed wood and metal. *Dries in approximately 30 minutes!*

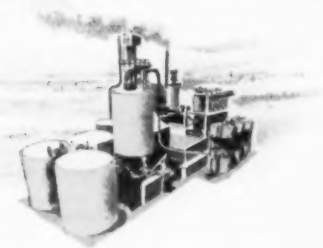
CONTRACTION EXPANSION Color Coat No. 261 leaves a tough pigmented plastic film that flexes with expansion and contraction of base material. *Ideal for color keying service lines!*

DURABILITY Color Coat No. 261 takes weather in stride, and also shows remarkable resistance to sunlight, gases, corrosive fumes, cleaning compounds and many solvents!

FRESH COLORS Color Coat No. 261 is available in Rose, Light Green, Light Blue, Light Yellow, Light Buff, Light Gray, Dark Gray and White—and in an unlimited variety of do-it-yourself colors. *Safe to store and apply!*

Think first of the coatings that last!

Insul-Mastic
CORPORATION OF AMERICA
7752 WEST 61st PLACE • SUMMIT, ILLINOIS



What Is Insul-Mastic Color Coat No. 261?

It is a modified acrylic resin dispersion combined with selected chemically inert pigments. Application is economical by conventional spray equipment, brush or roller.

MAIL THIS COUPON TODAY TO:
INSUL-MASTIC CORPORATION OF AMERICA
7752 West 61st Place, Summit, Illinois
☐ Send Information ☐ Have Representative call
Name_____ Title_____
Company_____
Address_____
City_____ State_____

For catalytic reforming..

Forty refineries specified Clark

User	*Location*	*No. of Units*
Atlantic Refining Company, The	Point Breeze, Pennsylvania	2
BP Refinery (Kent) Ltd.	Kent, England	1
Burmah-Shell Refineries Ltd.	Bombay, India	1
Bahrain Petroleum Company, Ltd., The	Bahrain, Persian Gulf	1
Caltex Petroleum Maatschappij N.V.	Pernis, Holland	1
Compagnie Francaise de Raffinage	La Mede, France	1
Gulf Oil Corporation	Girard Pt., Pennsylvania	4
Gulf Oil Corporation	W. Pt. Arthur, Texas	4
*	Eastern Canada	1
McColl-Frontenac Oil Company Limited	Montreal, Canada	1
Ohio Oil Co., The	Robinson, Illinois	1
Phillips Petroleum Company	Phillips, Texas	1
Phillips Petroleum Company	Kansas City, Kansas	1
Pure Oil Company, The	Smith Bluff, Texas	1
Refineria de Petroleos de Escombreras, S.A.	Cartagena, Spain	2
Shell Oil Company	Wood River, Illinois	2
Shell Oil Company	Deer Park, Texas	1
Shell Oil Company	Houston, Texas	2
Shell Oil Company	Anacortes, Washington	1
Shell Oil Company of Canada Limited	Montreal, Canada	1
Shell (Refining) Australia Pty. Ltd.	Geelong, Australia	1
Sinclair Refining Company	Marcus Hook, Pennsylvania	2
Sinclair Refining Company	E. Chicago, Illinois	2
Societe Francaise des Petroles BP	Dunkirk, France	1
Societe Industrielle Belge des Petroles	Antwerp, Belgium	1
Socony Mobil Oil Company, Inc.	Paulsboro, New Jersey	1
Societe per l'Industria Italiana del Petrolio	La Spezia, Italy	1
Standard Oil Co. of California	El Segundo, California	2
Standard Oil Co. of California	Richmond, California	2
*	Central Kansas	1
Standard Oil Co. of Ohio	Toledo, Ohio	2
Sun Oil Company	Toledo, Ohio	1
D-X Sunray Oil Company	Tulsa, Oklahoma	1
Suntide Refining Company	Corpus Christie, Texas	2
Texas Company, The	Wilmington, California	1
Texas Company, The	Laurenceville, Illinois	2
Texas Company, The	Westville, New Jersey	2
Texas Company, The	Pt. Arthur, Texas	5
Tidewater Oil Company	Delaware City, Delaware	1
Wilshire Oil Co. of California	Norwalk, California	2

*Name furnished on request

60% choose Clark

Vertically-split centrifugal compressors

Forty major refineries are using or have ordered Clark vertically-split centrifugal compressors for their reforming needs. That's over 60% of the total requiring centrifugal compressors.

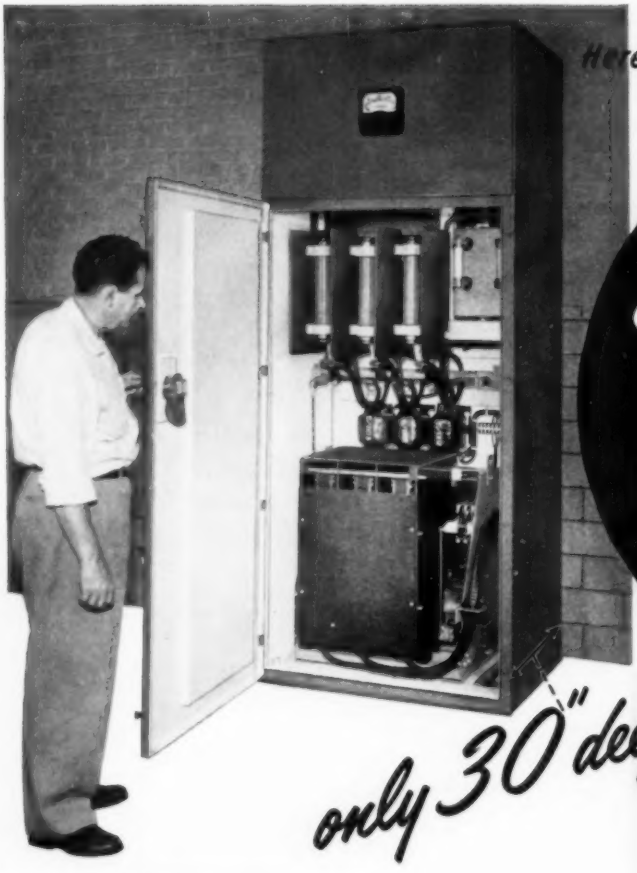
We could mention many reasons why these Clark units outsell all other makes combined, but we prefer to let the facts speak for us. Remember 6 out of 10 are Clark . . . how about your next reformer?

CLARK BROS. CO., OLEAN, N. Y.
One of the Dresser Industries
Offices in Principal Cities throughout the World

CLARK® — ONE OF THE DRESSER INDUSTRIES

Centrifugal Compressors

Here is **DESIGN LEADERSHIP** *...in Action!*



Save Space with New EC&M High Voltage (2200-4800 VOLTS) Starters

only 30" deep!

Accessible from Front...

(Solid back) • Starters may be mounted against wall or in double row, back to back

Safe...

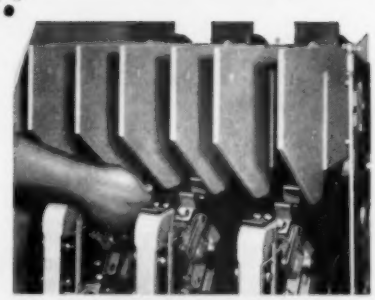
Starter DISCONNECTED from bus as door is opened
Low voltage section isolated from high voltage

Interlocked...

against accidental closure by simple rod mechanism
Large wiring space for incoming leads

EC&M's new ZHA Starter not only saves valuable floor space—it provides more accessibility and convenience than ever before. Starters are available with self-contained bus in isolated compartment. A gang of starters requires only one incoming feeder. Additional starters can be added as needed—with no sacrifice in neat, streamlined appearance. All starters are self-contained and complete with control transformer supplying low voltage for pushbutton circuits.

***Write for* BULLETIN 8130-F**



NO DRAW-OUT NEEDED • Arc shields slide out horizontally, making front and rear contact-tips removable with standard wrench.

3 Interrupting Ratings for Squirrel Cage, Synchronous and Wound-rotor Motors

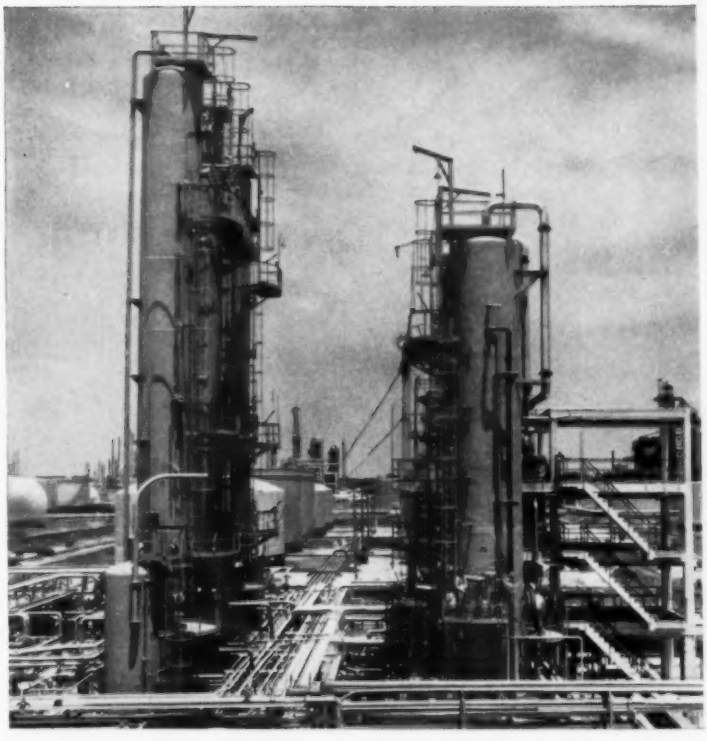
1. CLASS E 1 • 50,000 KVA (symmetrical) based on certified tests.

2. CLASS E 2 • With current limiting fuses and high interrupting capacity contactor. At 2300 volts: 150,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical. At 4,800 volts: 250,000 KVA, 3 phase; 60,000 RMS amperes asymmetrical.

3. VALIMITOR® • May be used on a bus of unlimited short circuit capacity, through the use of a contactor with an interrupting rating of 50,000 KVA, and reactors which limit any fault current to a maximum of 25,000 KVA.

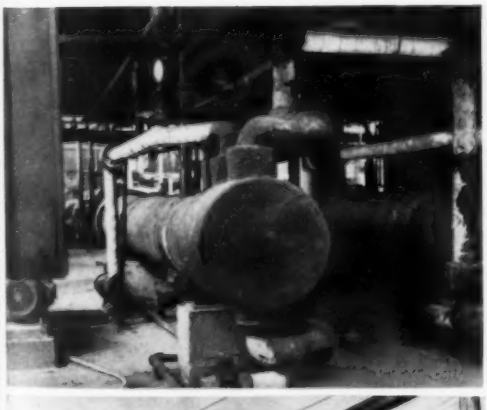
THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

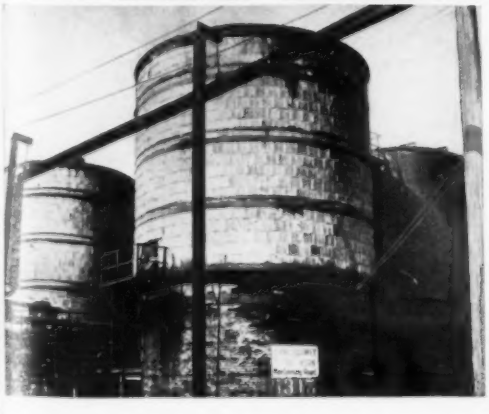
'95[illegible]



Take towers — This one is saving a large southern refinery $20,000 a year in maintenance costs. Solid 7/16-in. Monel* nickel-copper alloy walls save the caustic stripping tower in the refinery's Unisol unit from the corrosive bite of 47° Baume caustic at 290° to 300°.

Experience spurs use of Monel for handling caustics





Heat exchangers (left) — Here's a preheater that is exposed to contaminated caustic entering the regenerator tower and to pure caustic leaving. Despite severe conditions, the preheater is giving trouble-free service. Shell and tubes are Monel alloy.

Agitators (lower left) — In this large agitator tank at an eastern refinery, bottoms and sides up to 6 ft. were replaced with Monel alloy. A wise choice. Monel alloy has proved to be the most economical material to use for this service.

Experience like this has led to the use of Monel alloy for a variety of other caustic processing units: reboiler tube bundles, hot caustic lines and caustic storage vessels, to name a few. In petrochemical plants using caustics, Monel alloy guards product purity.

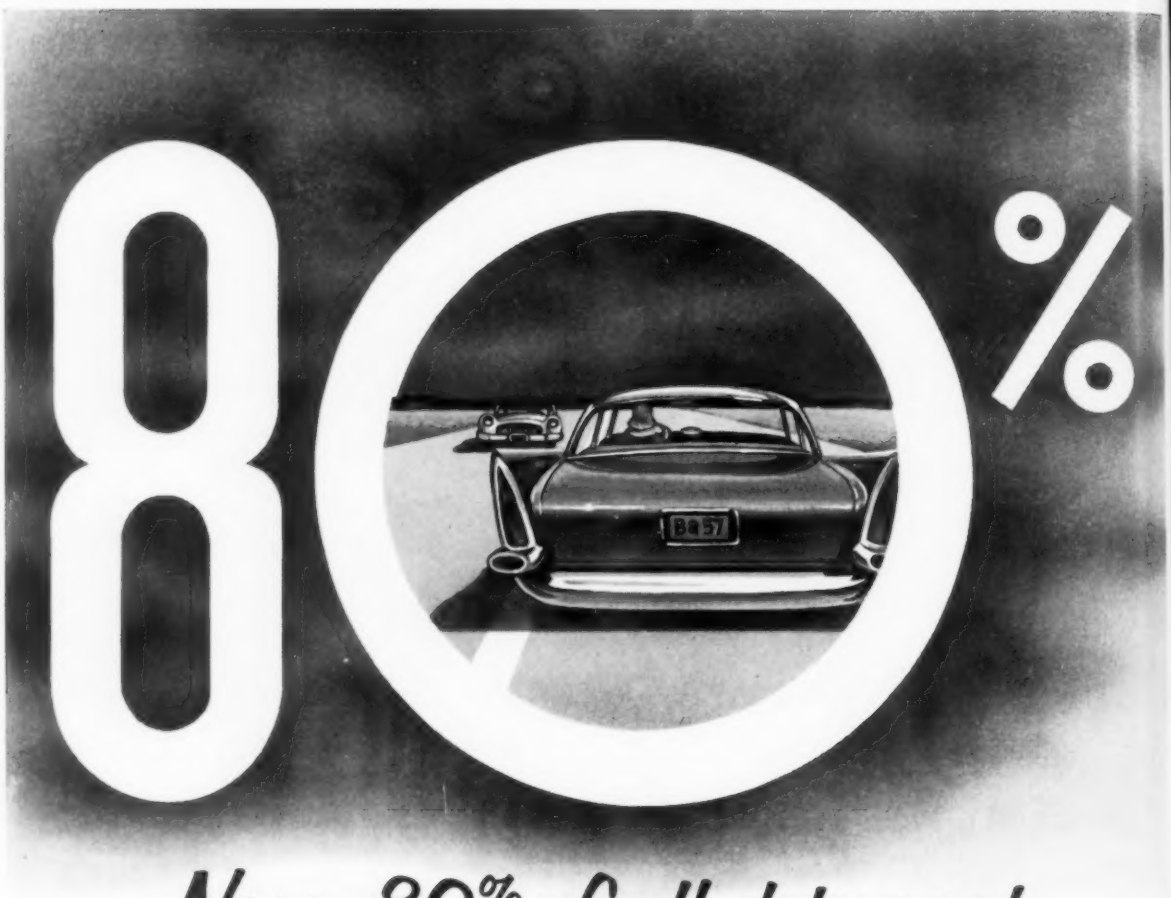
Making available field experience in overcoming caustic corrosion is one of Inco's many services. Why not take advantage of this service? Send us details of your problem and our Research and Development Engineers will work with you to provide a solution.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

Monel ... *for minimum maintenance*



Now–80% of all detergent oil-additives are Barium-based!

The overwhelming preference continues to grow . . . reflecting the outstanding performance of barium-based detergent oil-additives.

As the principal supplier of barium chemicals, Westvaco® developed readily soluble barium values in several forms from which these superior additives have been compounded. To keep well ahead of the demand, we have steadily increased our productive capacity and added substantially to our ample mineral reserves.

We will be glad to send you a copy of our 24-page booklet which gives complete information on Westvaco Barium Chemicals.

BARIUM OXIDE
BARIUM OCTAHYDRATE (FLAKE AND CRYSTAL)
BARIUM PENTAHYDRATE (FLAKE)
BARIUM NITRATE
BARIUM PEROXIDE
BARIUM CARBONATE
BARIUM SULFIDE

fmc chemicals

Westvaco Mineral Products Division
FOOD MACHINERY AND CHEMICAL CORPORATION

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BECCO® peroxygen chemicals • FAIRFIELD® pesticide compounds • FMC® organic chemicals • NIAGARA® insecticides, fungicides and industrial sulphur • OHIO-APEX® plasticizers and resins • WESTVACO® alkalis, solvents, phosphates, barium and magnesium chemicals

Ohio TYPE 1500 RETURN BENDS

flexibility of holding mechanism insures QUICK, POSITIVE plug alignment

eating of the plug is quick, easy nd positive in heading up the Ohio Type 500 Return Bend. The convex and ncave surfaces of the special equalizing ngs (illustrated in the inset above) ssure proper alignment between set llar and plug at all times under l operating conditions. There is xceptional strength of closure esign with uniform stress in tension nd shear about holding mechanism nd body. To assure easy removal, the ype 1500 Return Bend has a floating t collar which eliminates thread alling and/or thread seizure.

Other *plus* features of the Ohio Type 1500—*SELF-CONTAINED CLOSURE MECHANISM* in which all parts handle as a unit for faster heading up or unheading . . . *POSITIVE PLUG PULLER DEVICE* incorporated in closure mechanism eliminates need for special pulling tools . . . *GREATER SAFETY* because plug cannot blow out; trapped gases are relieved through weep-holes while set collar is still engaged . . .

OUR 50th YEAR 1907 1957

FOUR SERIES—850, 1275, 1700 and 2000, with ten sizes in each series (2" to 6⅝").

THE OHIO STEEL FOUNDRY CO.
SPRINGFIELD, OHIO

Plants at Springfield and Lima, Ohio

ORBG

TO THE MAN ABOUT TO MAKE

A major decision

Somewhere, today—or tomorrow—some man in some company will be making the important decision to embark on a major expansion program.

To that man and his company Procon offers a world-wide construction organization which has proven—time and again—its ability to get the job done right up to the minute and right up to every specified requirement.

Whatever the job is, oil refinery, petrochemical plant or chemical plant, Procon's complete design, engineering and construction facilities, its background of proven accomplishment over the years, justify the final decision, "Give the job to Procon!"

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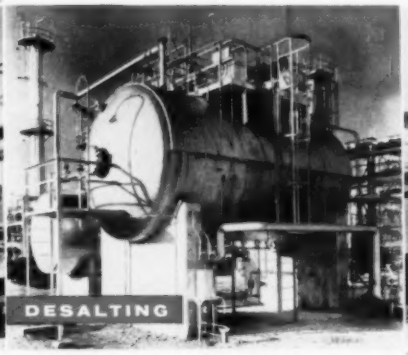
WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES.

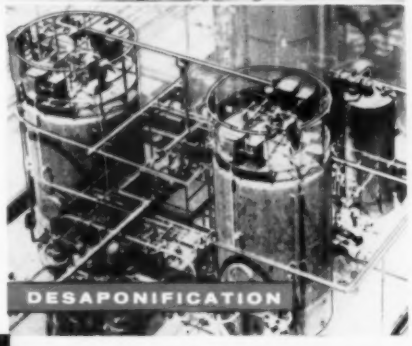
PETRECO electric processes are contributing to the AUTOMATIC CONTROL of petroleum producing and refining operations

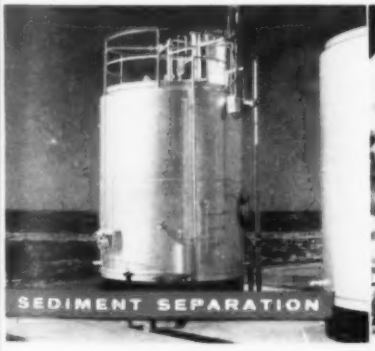


Throughout the world, Petreco electric processes are eliminating the many problems and uncertainties that used to grow out of processing guesswork.

By incorporating the advantages of automation, Petreco units are changing many a processing "art" to an exacting *science*.

Petreco designs, constructs and services electric petroleum treating equipment to perform many processing functions—automatically, continuously and with precision control.





For complete information on any or all of these processes:

- ELECTROFINING
- SWEETENING
- DESALTING
- LUBE OIL TREATING
- DESAPONIFICATION
- SEDIMENT SEPARATION
- DEHYDRATION

WRITE OR CALL

PETRECO®

A DIVISION OF PETROLITE CORPORATION

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Specialized Electric Petroleum Treating

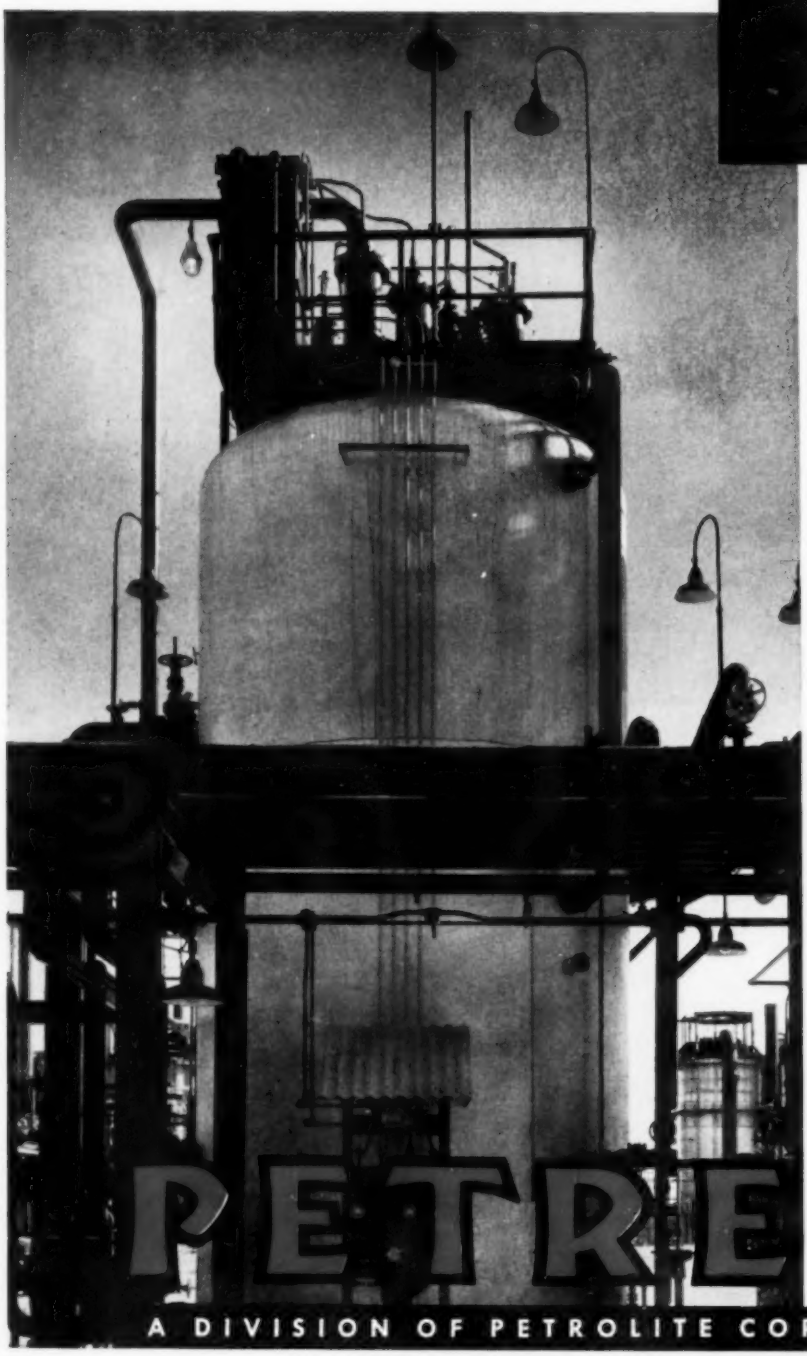
DESALTING • DEHYDRATING • CAUSTIC WASHING • ACID TREATING • DOCTOR TREATING
SWEETENING • NAPHTHENIC ACID REMOVAL • SEDIMENT REMOVAL

YOU CAN SAVE UP TO 70%...

ON INSTALLATION COSTS

if you

- *Caustic Wash*
- *Acid Treat*
- *Doctor Treat*
- *Water Wash*
- *Remove Nitrogen & Arsenic*



by installing PETRECO ELECTROFINING

Petreco Electrofining equipment can easily save you up to 70% on installation. The reasons are readily apparent: it's a once-through, single unit installation that requires fewer pumps, less piping, smaller area.

. . . and also save on operating costs

because it's a continuous, automatic process in which the distillate is contacted with exactly the *right amount* of treating agent, in the *correct intensity* for the proper time. The result is a clean separation of hydrocarbon and chemical agent, with a minimum carry-over and product loss.

WE'D LIKE TO TELL YOU MORE

about the Petreco Electrofining Process . . . and we do in our new Bulletin. Write for your free copy.

PETRECO®

A DIVISION OF PETROLITE CORPORATION

SPECIALIZED ELECTRIC PETROLEUM TREATING

DESALTING • DEHYDRATING • CAUSTIC WASHING • ACID TREATING • DOCTOR TREATING
SWEETENING • NAPHTHENIC ACID REMOVAL • SEDIMENT REMOVAL

DT-57-5

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a lifetime studying
HEAT EXCHANGER TUBE
problems...

but there's an **easy** way
to save yourself
that kind of work

Simply pick the brand of Heat Exchanger Tube that starts out in life as a CONTINUOUS-CAST billet . . . Scovill Phosphorized Admiralty. Only in Scovill's unique continuous casting process do *many* carefully controlled melts of alloy BLEND together in the casting process to produce such SOUND and UNIFORM billets for subsequent hot extrusion and cold-drawing into Heat Exchanger Tube. Exceptional uniformity of chemical composition and uniform distribution of the inhibitor (phosphorus) mean longer tube life.

Scovill Manufacturing Company, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

simply put it up to... **SCOVILL**

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Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Naval Brass • Red Brass, 85% • Deoxidized Copper Arsenical Copper • Cupro Nickel 10%—20%—30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

petro

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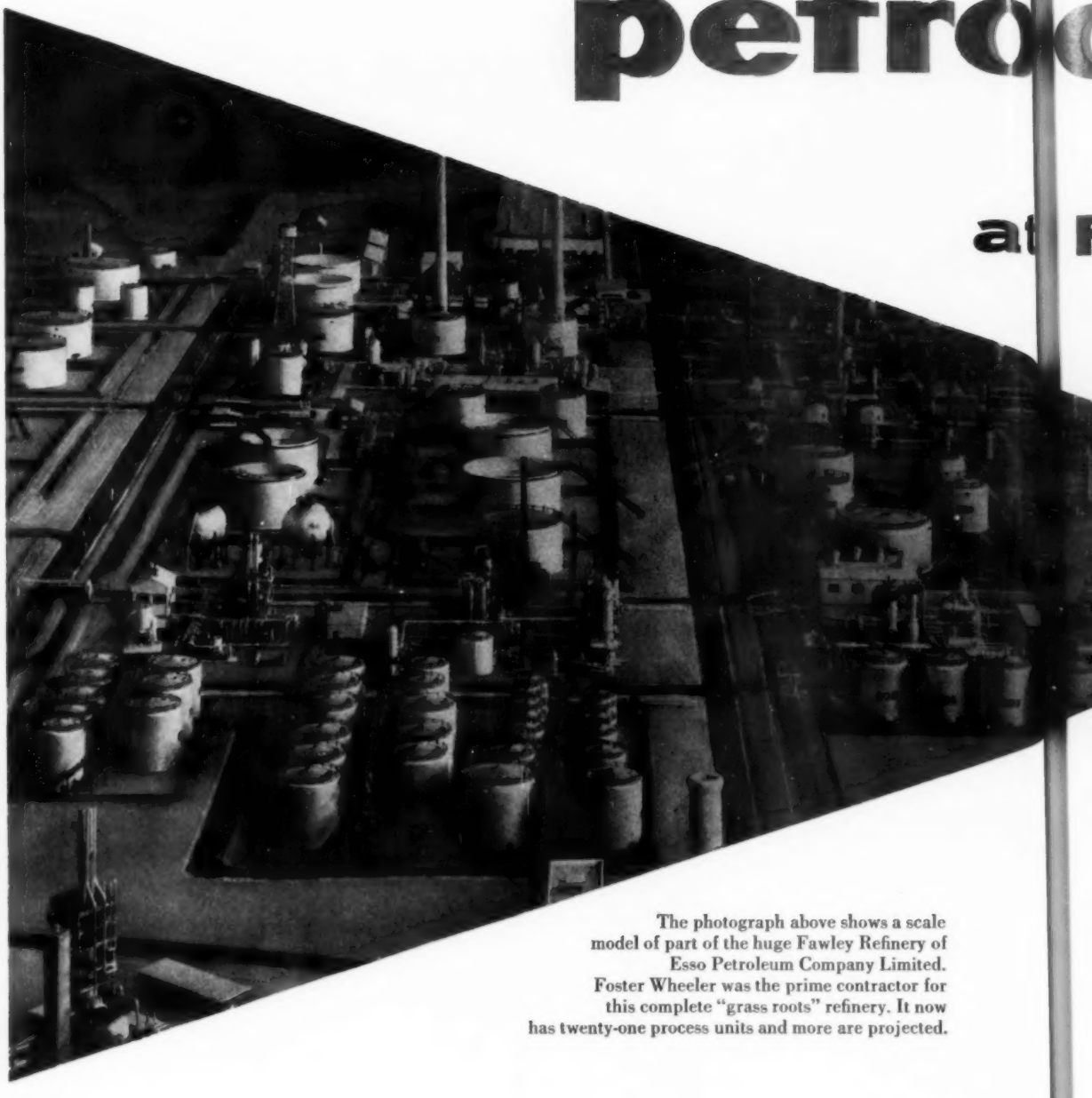


The photograph above shows a scale model of part of the huge Fawley Refinery of Esso Petroleum Company Limited. Foster Wheeler was the prime contractor for this complete "grass roots" refinery. It now has twenty-one process units and more are projected.

• FOSTER WHEELER DESIGNS AND BUILDS

PETROLEUM, CHEMICAL AND PETROCHEMICAL PROCESSING PLANTS

ANYWHERE IN THE WORLD

FW FOSTER

NEW YORK • LONDON

chemicals

FAWLEY

NEW PETROCHEMICAL PLANT for England's Largest Refinery, will be designed and built by Foster Wheeler

SYNTHETIC rubber and plastic hydrocarbon raw materials (ethylene, propylene, butylene and butadiene) will be produced from 250,000 tons per year of petroleum intermediates in a major process installation at the Fawley, England, refinery of Esso Petroleum Company Limited. Foster Wheeler, who built the new Fawley petroleum refinery, the largest in England, will also provide mechanical design and construction for this petrochemical project. Esso Research and Engineering Company supplied basic process design data.

These basic hydrocarbon products represent a new and very substantial source of raw material for the British synthetic rubber and plastic industries.

Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

WHEELER

ARIS • ST. CATHARINES, ONT.

You should know!

SERV-RITE®
Thermocouple Wire
with
BONDED STAPLE INSULATION

Many inherent advantages of this newly developed bonded staple yarn insulation make it adaptable to a wide range of applications. It is suitable for continuous use at temperatures up to 1600° F. and in adverse atmospheric conditions. It is flexible, tough, does not powder, and can be color coded.

Gordon's research and product development laboratory has worked out the application of bonded staple yarn to thermocouple wire and, now, offers to industry any SERV-RITE thermocouple wire or thermocouple extension wire with this new insulation. The commonly used wires are available for delivery from stock.

Gordon service engineers shall be glad to advise on the use of this new insulation in your particular applications. Write for full particulars.

Ask for Bulletin No. 1200-1

This bulletin gives the advantages of bonded staple yarn insulation and ordering information on several commonly used wires.

7058

CLAUD S. GORDON CO.
Manufacturers • Engineers • Distributors

633 West 30th Street, Chicago 16, Illinois
2001 Hamilton Ave., Cleveland 14, Ohio

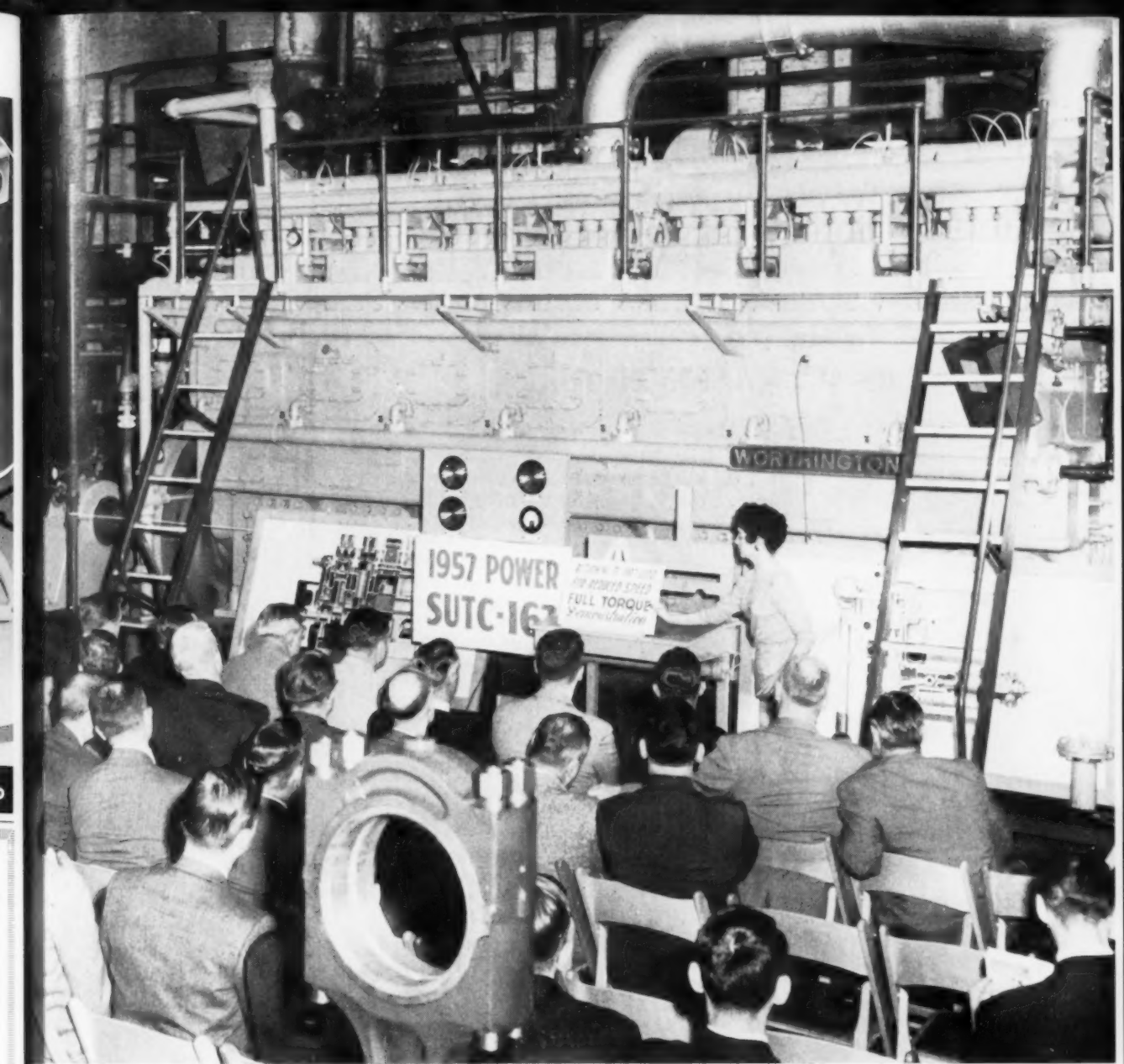
SPEARHEAD
GASKET CUTTERS
. . . cut the gaskets you need as you need them — any size, any shape, any time, any place, from any pliable sheet material. The SPEARHEAD Extension cutter, No. 747 cuts round from 1" to 13" and with extension arms can cut any size. The SPEARHEAD Handy Model, No. 750 cuts round ¼" to 6", and any size odd shapes and straight pieces. Eliminate the need for expensive gasket inventory. With these two SPEARHEAD Gasket Cutters in every man's tool kit, you cut them as you need them — quick!
For circular, prices, and complete information, contact your local supplier.

Zimmerman Packing - Cincinnati 12, Ohio

☞ IN THE **JUNE** PETROLEUM PROCESSING

How to Do a Better Job of
LOW TEMPERATURE
INSULATION

☞ **A SPECIAL REPORT**—Insulation for "cold" areas, below freezing, require different materials, different methods, and a radically different approach than insulation for "hot" areas. Don't miss this "must" piece that describes the basic low temperature insulation problems and today's accepted methods of solving them.



At 1957 Power Fair, engineers witness proof of...

TURBO-UNIFLO PERFORMANCE

There's no better way to judge the performance of an engine than to see it in operation. That's why more than 250 process and pipeline engineers recently gathered in Buffalo, N. Y., to attend Worthington's 1957 "Power Fair."

Star of the show was the new SUTC TURBO-UNIFLO gas engine compressor. The only two-cycle engine compressor with exhaust powered turbocharging from start-up through full-load, the TURBO-UNIFLO features remarkable stability over the complete range of speed and load requirements.

The audience was impressed by the TURBO-UNIFLO's smooth start and quiet operation (as much as 20 decibels quieter than engines with mechanically driven scavenging systems). Next came the overload demonstration to prove the very conservative engine rating.

To show stability, engine speed was gradually reduced while maintaining full torque. 320 rpm . . . 270 rpm . . . 230 rpm (at this point someone offered to bet that it couldn't go below 150). But down it went . . . all the way to 105 rpm before reaching its stalling point.

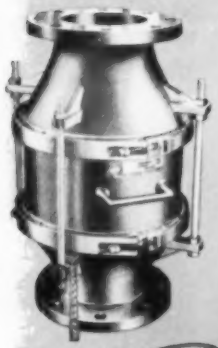
But this is only half the story. Your Worthington representative will be glad to give you all the facts about the new SUTC TURBO-UNIFLO engine. Get in touch with your nearest Worthington district office or write to Section E-73, Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) 1955, Ltd., Brantford, Ont. E-73

WORTHINGTON

For Maximum Protection of Volatile Liquids in Storage

. . . Equip Your Tanks With BS&B *Lightweight* Tank Vents and Flame Arrestors!

The BS&B Tank Vent, Type 76-16, features a floating seal for positive shut-off under both pressure and vacuum. Positive seal is effected without utilizing the weight of the hinged cover. Vapor pressure within the tank (or atmospheric pressure in the case of vacuum) maintains seal. Cover and major internal components are aluminum with stainless or plated steel hardware; plastic coated bases are cast iron. These vents mount to 125 lb. ASA bolting circles in sizes 6″ through 12″.



BS&B Flame Arrestors, Type 76-18, for free vent systems, may be mounted either horizontally or vertically. End connections are 125 lb. ASA flanged for mounting to open vent lines of process vessels. Flame bank end flanges are identical to those of the Type 76-17 Arrestor Vent Bases (below). Lightweight, maximum venting capacity and servicing ease are important features of the Flame Arrestor.

BS&B Arrestor Vent, Type 76-17, combines the features of Types 76-16 and 76-18 described above. It functions both as a tank breather and as a cartridge type flame arrestor to prevent ignited vapors from flashing back into the tank. Flame bank is secured by two quick opening V-clamps for easy access to unit for inspection or servicing. Normal venting with the flame bank removed is maintained by simply securing the top unit to the base with one V-clamp. Internals of flame bank are alternate layers of flat and corrugated aluminum strips, in a continuous roll.

Ask your BS&B Representative for Catalog 76-16 or write direct to . . .

BLACK, SIVALLS & BRYSON, INC.

Safety Head — Vent Valve Division, Dept. 2-D5
7500 East 12th Street
Kansas City 26, Missouri

SEND FOR MORE INFORMATION ON ADVERTISED PRODUCTS OR SERVICES

USE EASY SERVICE CARD ON TRADE SHOW BACK COVER

Memo: to all process engineers—

Why Tolerate Liquid Carry-Over?

...when METEX Hi-Thruput Mist Eliminators can deliver 100% efficiency!

● Whether it's on a vertical tube evaporator, a packed column, knock-out drum or a vacuum pipe still, there's no necessity, *today*, to permit poor liquid-vapor separation to pull product quality and profits down. With Metex, you have a unit that's *different*. Hundreds of thousands of openings and wire surfaces, so combined as to baffle uprising gas-liquid streams in multiples of thousands of physical separating contacts, can and *do effect complete gas-liquid-contaminant separation.*

No other unit delivers more efficiency, offers longer life or less maintenance. Used and specified by hundreds of process engineers, Metex Hi-Thruput Mist Eliminators are the standard of excellence wherever efficient entrainment separation is important to good production and profits.

• Write for Bulletin ME-6

METEX QUALITY PRODUCTS

• metal textile corporation

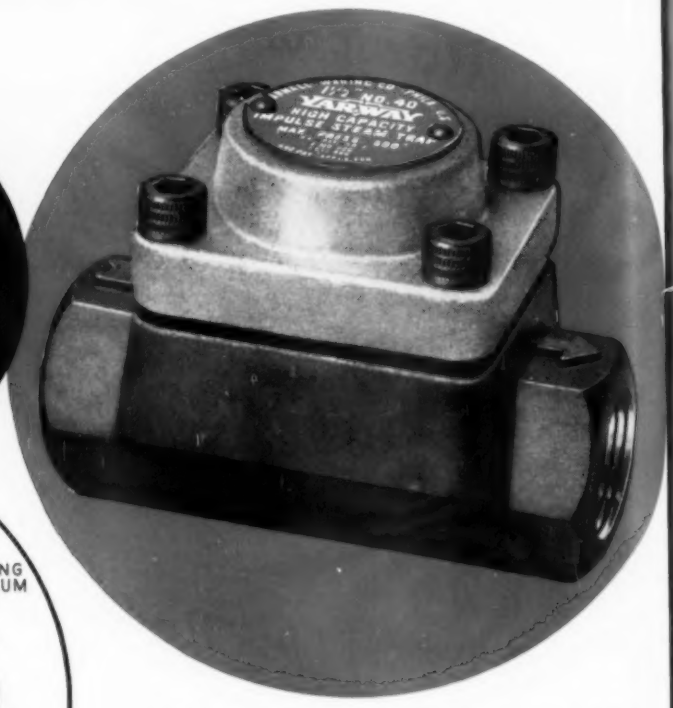
roselle, new jersey

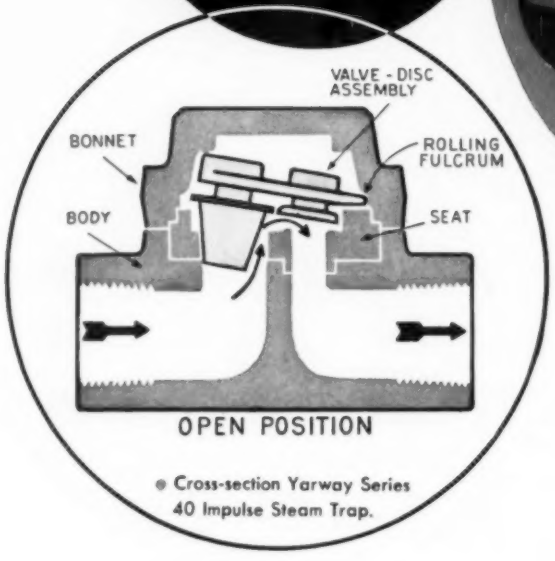
Representatives in principal cities throughout the world.

7-072

This YARWAY IMPULSE STEAM TRAP is for extra heavy condensate loads

YARWAY SERIES 40





● Cross-section Yarway Series 40 Impulse Steam Trap.

The famous Yarway "impulse" principle of thermodynamics that revolutionized steam trapping many years ago, is now applied to a steam trap for extra heavy condensate loads—the Series 40 Impulse Steam Trap. Users report with this trap they obtain quicker heating, higher and more even temperatures in their process equipment.

It also incorporates all the other advantages of earlier Impulse trap designs, such as—immediate response to load changes, no air binding, light weight and small size. Maintenance is low, thanks to stainless steel body and working parts.

High condensate capacity of Yarway Series 40 Impulse Steam Traps makes them ideal for heavy condensate loads on large autoclaves, cooking kettles, dryers, heat exchangers, heating coils, presses, unit heaters, etc.

Suitable for all pressures up to 600 lbs. maximum, without change or adjustment. Operates against back pressures up to 50%. Five sizes, ½", ¾", 1½", 2" and 2½".

Your Yarway man will furnish a Yarway "40" for 90-day free trial in your plant without obligation, or write for Yarway Bulletin T-1746.

YARNALL-WARING COMPANY
153 Mermaid Avenue, Philadelphia 18, Pa.

STANDARD SERIES 60
YARWAY IMPULSE TRAP

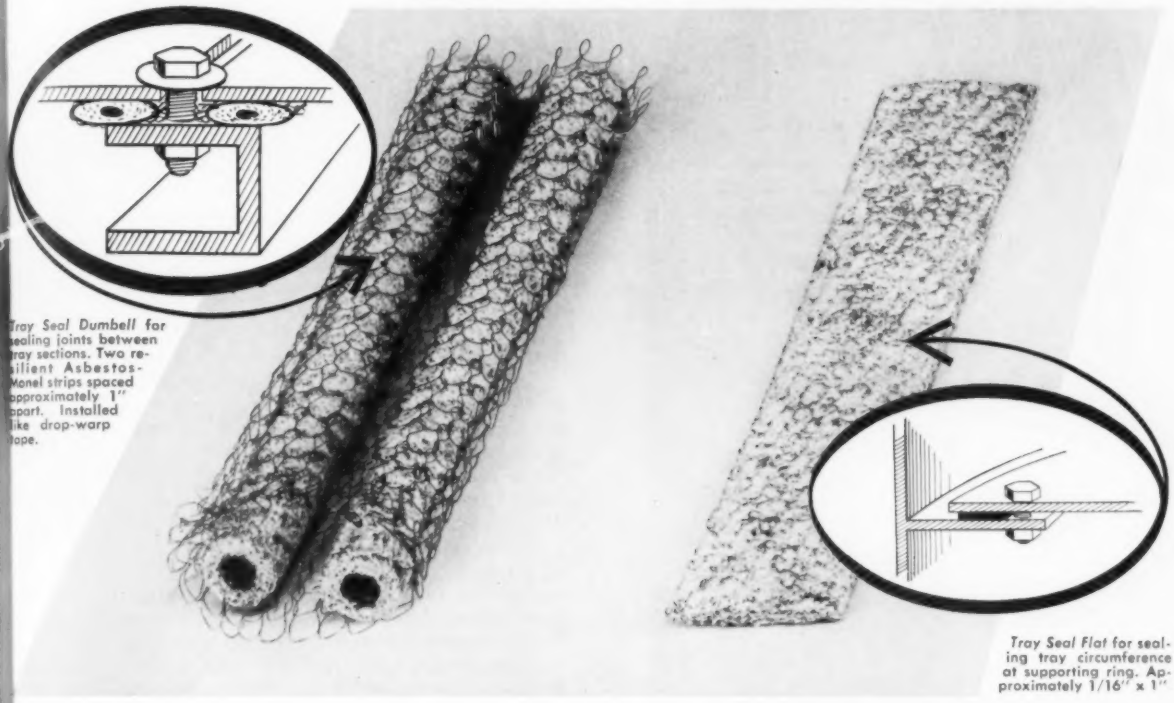
For normal steam trap applications the standard Series 60 Yarway Impulse Steam Trap is recommended. For *extra light* condensate loads use the Yarway 20-A Impulse Steam Trap.

Both are described in Yarway Bulletin T-1739X.

YARWAY IMPULSE® STEAM TRAP

OVER 1,000,000 YARWAY IMPULSE STEAM TRAPS USED

Now—a better seal against leakage across fractionating trays



Tray Seal Dumbell for sealing joints between tray sections. Two resilient Asbestos-Monel strips spaced approximately 1" apart. Installed like drop-warp tape.

Tray Seal Flat for sealing tray circumference at supporting ring. Approximately 1/16" x 1"

•Metex Tray Seal Tapes—Pure Asbestos Fiber and Knitted Monel[1] Wire...

Proved by more than two years on-stream service in a large East Coast refinery, Metex Tray Seal Gaskets[2] have cut leakage previously experienced by as much as 84%! Because they contain no cotton, Tray Seal Tapes showed no charring, even at temperatures of 750°F. No replacements were needed at turn-arounds and tightening of a few bolts was the only attention required.

Installed like conventional tapes, these new gaskets have proved more effective than any other gasketing previously used. Bolts between tray sections are readily pushed through the sheath around Tray Seal Dumbell—no punching required. Use Tray Seal Flat around tray circumference and where un-punched gasketing can be used.

If you are faced with operating and production problems resulting from excessive tray leakage, write today for detailed information and experience data on these two new Tray Seals. No obligation, of course.

1. ®International Nickel Co. 2. U. S. Patent #2,761,203 dated September 4th, 1956.

QUALITY METEX PRODUCTS

METAL TEXTILE CORPORATION

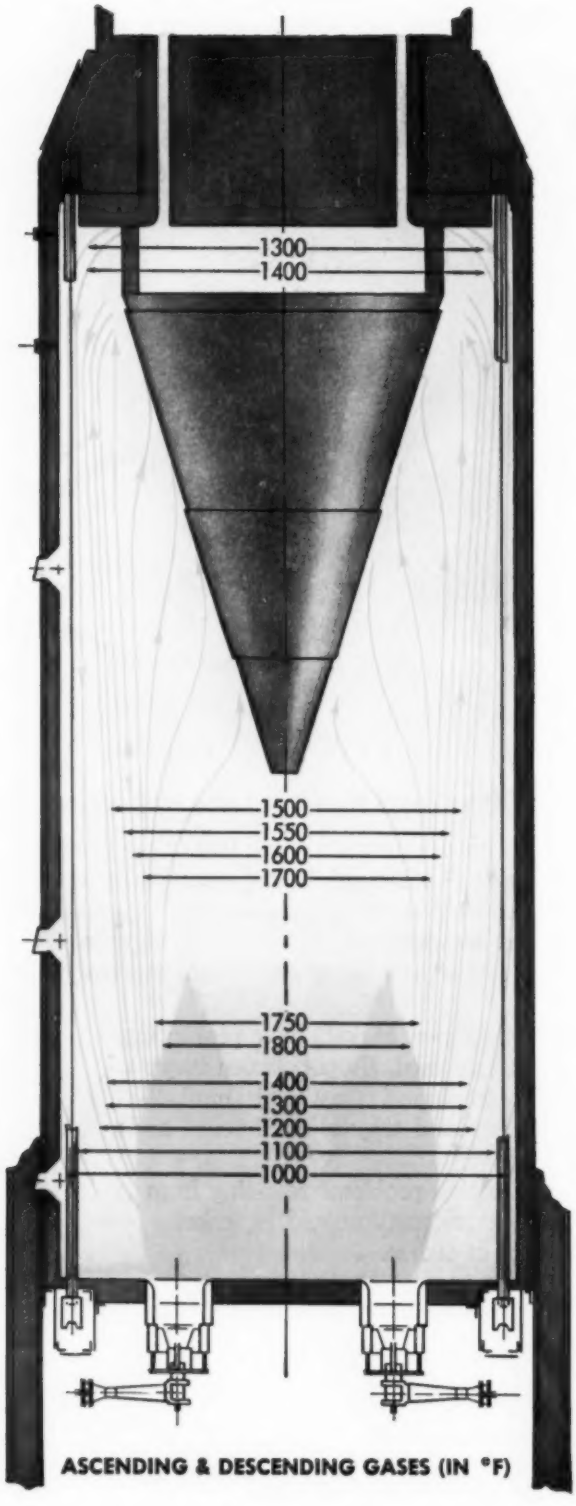
ROSELLE, NEW JERSEY

Representatives in principal cities throughout the world

Send for New Bulletin

7-074

PETROCHEM-ISOFLOW FURNACES



ASCENDING & DESCENDING GASES (IN °F)

Here are the facts!

The first vertical cylindrical heaters provided even circumferential heat input, but vertical flux distribution varied considerably, from high transfer at the bottom of the tubes to low rates at the top. Improvements in design during the past twenty years have overcome this difficulty, by providing proper firebox proportions, a reradiating cone, and burners specifically designed to the requirements of the furnace.

It is significant that *only Petrochem-Isoflow furnaces* incorporate all three of these critical items of design.

The small, hot cone tip reradiates to the tubes, across a considerable distance. Because of the conical shape employed, each higher element of the cone is of larger area, and closer to the tubes than the section below. These factors compensate for decrease in cone temperature from tip to base, provide relatively constant radiant heat transfer over entire upper tube length.

The cone also serves to divert flue gases along the upper ends of tubes, which adds convection heat transfer over this length. It also initiates a high rate of firebox recirculation of combustion products, by cooling the gases in their passage across the tubes.

Being cooler, and therefore heavier than the rising gases in the center of the firebox, the gases adjacent to the tubes fall to the bottom of the heater by thermal siphon effect, increasing the heat input to the rear of the heating elements by convection. The descending gases also serve as a buffer between hot gases and the lower ends of the tubes and dilute the products of combustion. The special burners, by developing a symmetrical flame pattern, contribute to the equality of heat distribution over the entire radiant tube length.

Of the design features mentioned above, the cone is of the greatest significance because it is essential to even radiant heat distribution.

Experienced operators know that even heat distribution improves product quality, decreases tube deteriorations, results in longer, trouble-free operating cycles.

The Data Shown in the Drawings are ACTUAL PERFORMANCE RECORDS

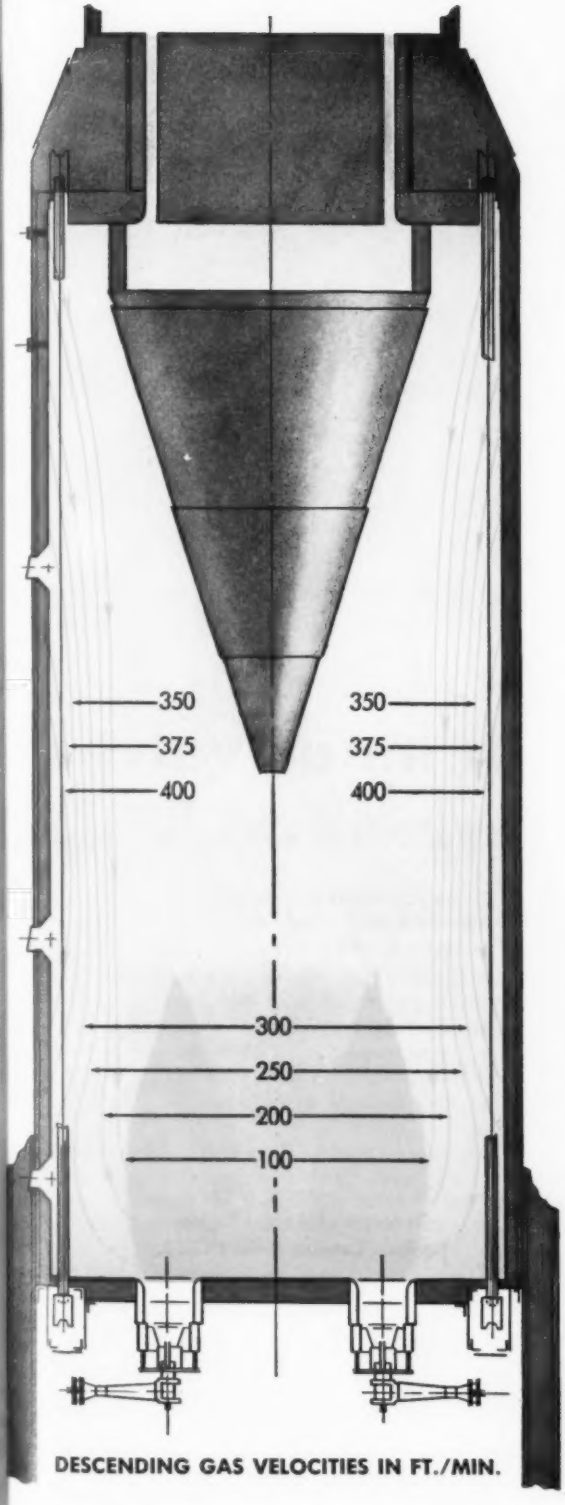
To check radiant flux distribution in Petro-Chem furnaces, exhaustive tests were made under actual operating conditions; some of the results of these tests are indicated in the two adjacent drawings.

Left: Plot of isotherms in a Petrochem-Isoflow firebox illustrating the uniformity of firebox temperature.

Right: Plot of flue gas flow patterns and velocities, demonstrating the high gas recirculation rates.

Both of these phenomena are the result of proper firebox proportions, the two-fold action of the cone, and symmetrical flame pattern.

Provide EVEN HEAT Distribution !



DESCENDING GAS VELOCITIES IN FT./MIN.

In addition to even heat distribution, other all-important factors which determine the value and efficiency of processing furnaces include:

MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved more economically desirable by any comparison.

More Than 1350 Petrochem-Isoflow Furnaces have been installed since 1940—an unequalled record of acceptance based on proved performance.

PETROCHEM
—ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT COMPANY, INC.
122 East 42nd Street, New York 17, N. Y.

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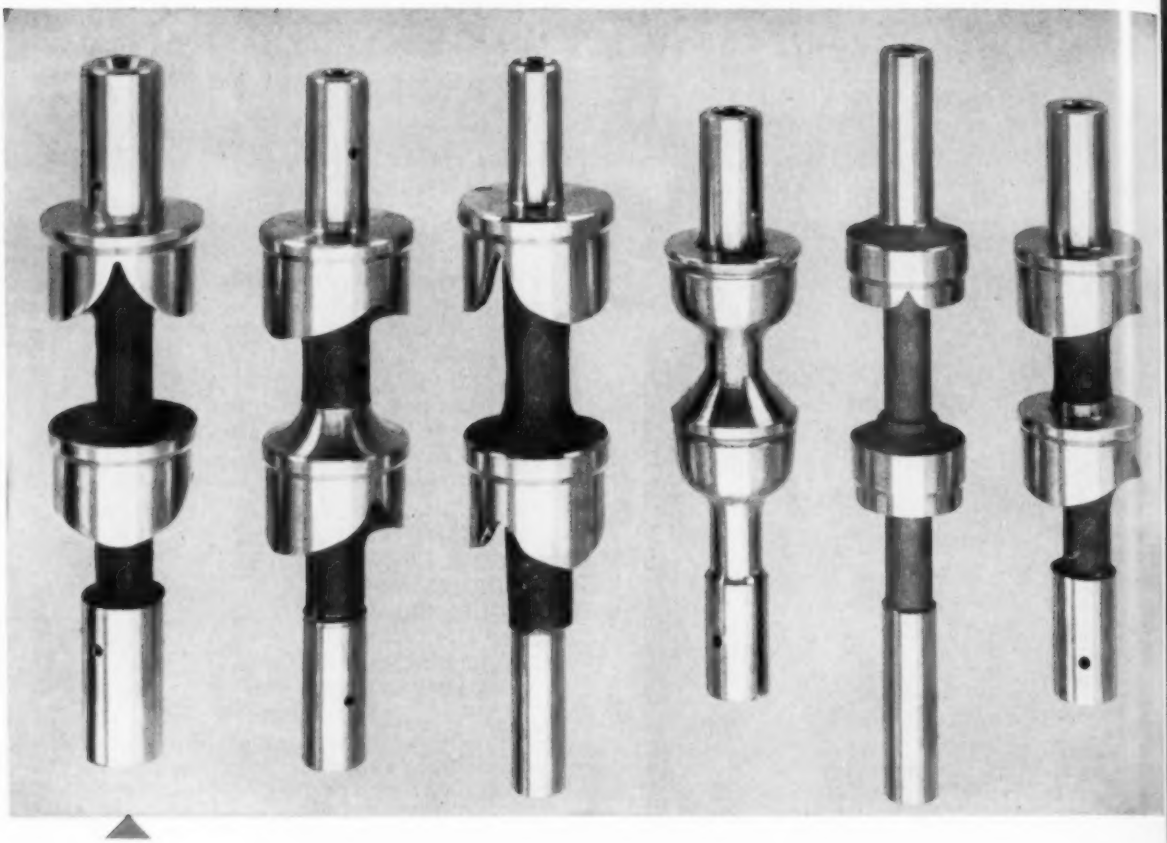


Inner secrets of inner valves

FACTS EVERY CONTROL VALVE USER SHOULD KNOW

This is a rare photograph . . . presented in a completely unretouched form. It shows the inner valve of leading makes of diaphragm control valves. The inner valve determines the control result.

The most amazing fact is the size . . . all are *listed* as two inch valves. All are high lift. But compare them.

Note the KIELEY & MUELLER inner valve at the far left. It equals the others on every point of consideration; exceeds on many. Look at the diameter across the skirt . . . that's one reason for the remarkable C_v of K&M valves. Look at skirt length; the solid, not fabricated, design. Measure the rugged guide posts and the large column. Examine the machining and the super-finishing.

It's no wonder . . . K&M is *the valve that likes to be compared*. It's a better valve and a better value by every measure of comparison.

FOR THE COMPLETE FACTS . . .
write for the K&M Valve Engineering Data Catalog, Bulletin CV53.

diaphragm control valves

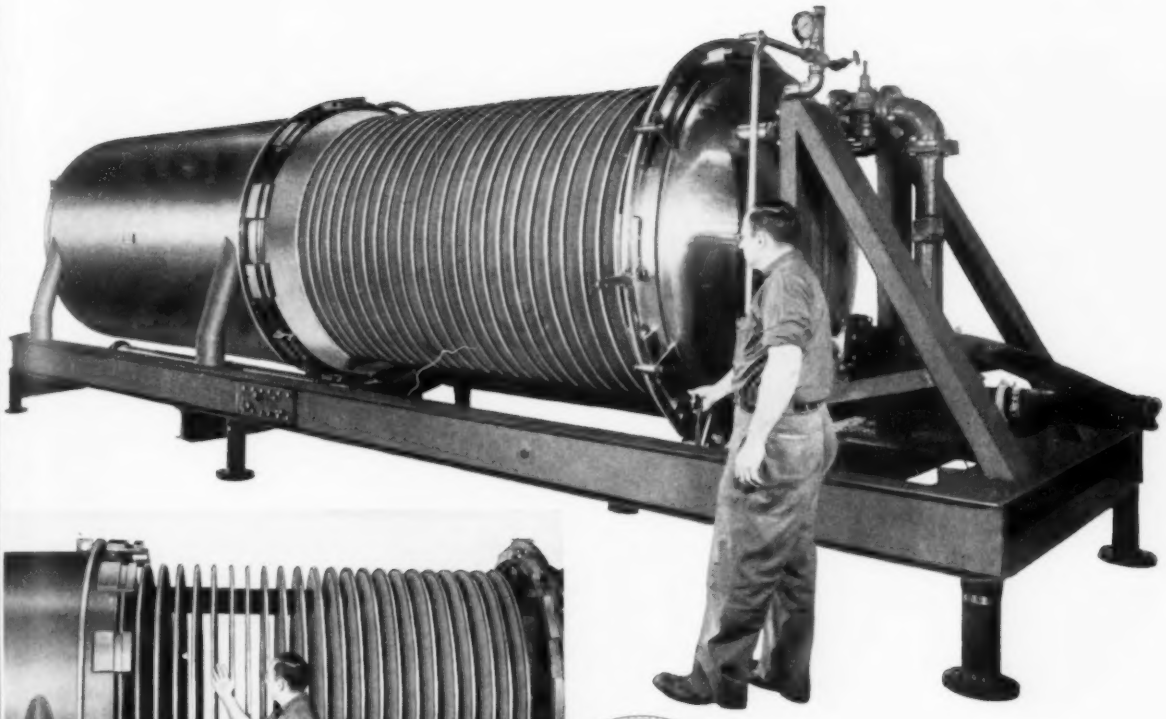
K&M

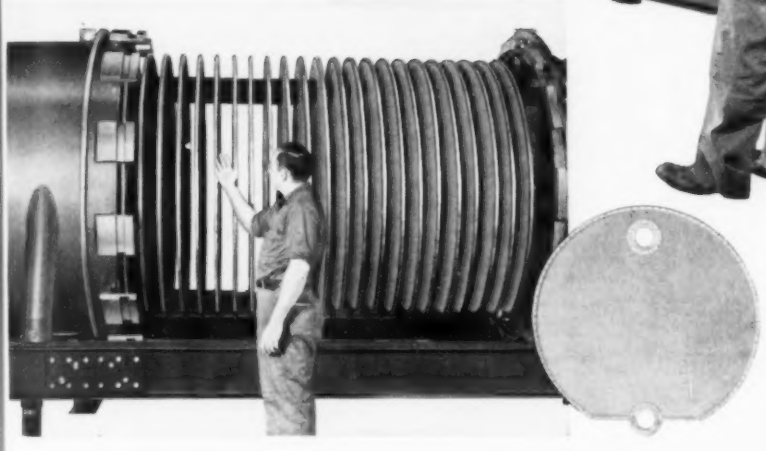
Our 78th Year

KIELEY & MUELLER, INCORPORATED

Oldest Pressure and Level Control Valve Manufacturer

64 Genung Street, Middletown, New York





Built to handle products with a high percentage of bulky solids, with long operating cycles.

SPARKLER Heavy Duty Filter Model MCR

Retractable tank . . . quick opening filter

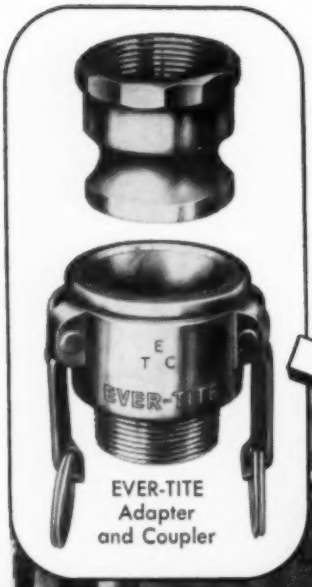
1. The retractable tank, with labor-saving hydraulic power, and finger tip control, is the answer to the demand for an automatic fast-opening filter.
2. Fixed immovable head, eliminates the necessity to break pipe connections with the attendant danger of spillage in opening the filter.
3. Fast action, Sparkler Passalaqua, cover seal. Locking ring actuated by a single hand lever enables the operator to break the filter cover seal in seconds without mechanical power. O-ring gasket seal tightens with increased internal pressure. A.S.M.E. approved.
4. MCR plates have a large outlet at the top in addition to the bottom drainage outlet. This reduces flow resistance through filter elements.
5. Plates are spaced far apart with plenty of room to develop a full size cake without clogging or restricting flow space. This increases the total throughput and results in a longer cycle.
6. The MCR filter is designed to speed up all heavy duty filtering operations with a resulting lower labor cost and greater daily output.

Available in capacities of 100 sq. ft. to 2000 sq. ft. Write for bulletin and give details of your filtering problem.

SPARKLER FILTERS

SPARKLER MANUFACTURING COMPANY
MUNDELEIN, ILLINOIS

Sparkler International Ltd., plants in Canada, Holland, Italy and Australia
Exclusive filtration engineers for over 35 years



EVER-TITE Adapter and Coupler

EVER-TITE

QUALITY QUICK COUPLINGS

do a faster, safer job

At the Kobuta plant of Koppers Company, Inc.

EVER-TITE Adapter and Coupler

EVER-TITE Shank Hose Coupling

Install EVER-TITE COUPLINGS

on loading racks • manifolds in storage areas manifolds in blending operations • container filling devices • fire hydrants and water lines • acid handling at storage and transfer locations

REFINERIES and petrochem plants are discovering that in every operation that calls for couplings, they can *speed work, prevent leakage, save wear on equipment* by using EVER-TITES.

Ever-Tite engineering and precision are your assurance of the utmost coupling value. Tightness is predetermined in manufacture by positive gasket compression. There are no sliding rings—no springs, ball bearings, snaps or lugs to fit. You just slip the coupler over the adapter and close the handles.

Standardize *now* on EVER-TITE Quick Couplings—backed by almost two decades of pre-eminence.

Brass • Aluminum • Stainless Steel • Malleable Iron

Other materials available on request

EVER-TITE COUPLING CO. INC., 254 WEST 54th STREET, NEW YORK 19, N. Y.

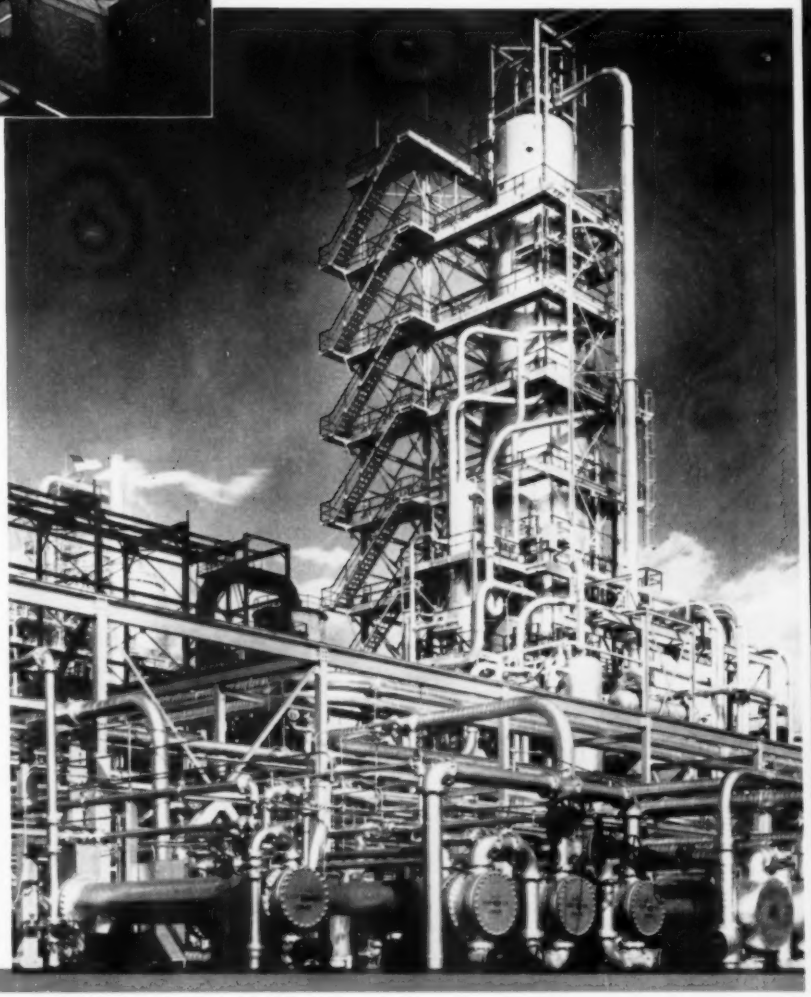
PROBLEM

SOLUTION

RESULTS

YOU'LL get the completely satisfactory results you can expect on your project when you employ the diversified knowledge, world-wide experience and specialized talents of engineers in the McKee organization.

McKEE BUILDS PLANTS
THAT EARN PROFITS



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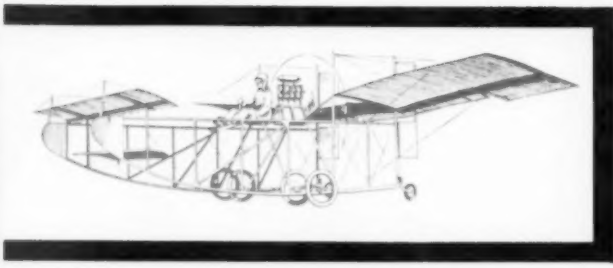
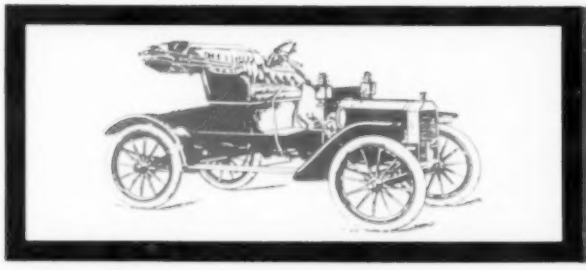
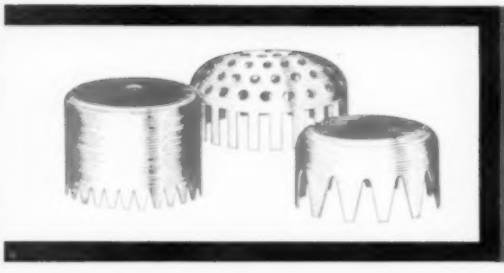
there's been

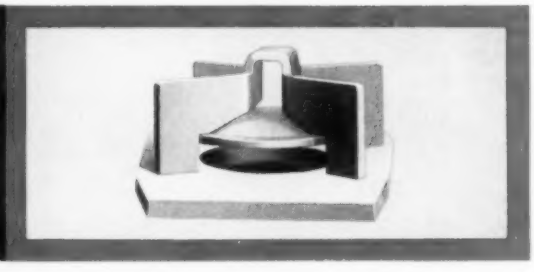


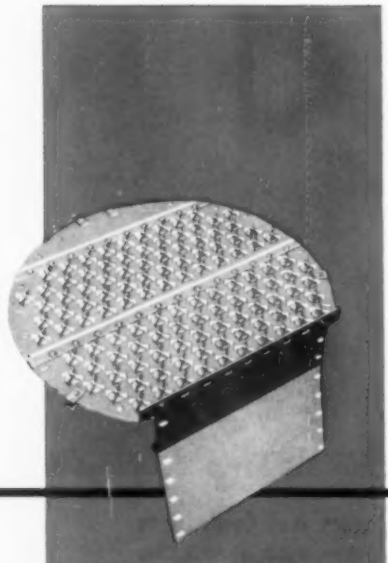
some changes made



in fractionating trays, too!







REPRESENTATIVES

Today's trend in progress is away from "horse-and-buggy" bubble trays to Koch's jet-age **FLEXITRAY** . . . and, for good reason!

With "Flexitray," the entire tray area is available for vapor-liquid breakout . . . no obstruction to liquid flow exists . . . vapor separates at lower velocities. "Flexitrays" remain cleaner – longer!

With its extreme flexibility and capacities, it is small wonder that major companies – looking for the best designed trays – have adopted "Flexitray" for more than 400 **NON-CAPTIVE** installations.

Write . . . wire . . . phone your nearest Koch representative or:

KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS

321 WEST DOUGLAS AVENUE, WICHITA 2, KANSAS

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Tulsa, Oklahoma Representative: W. C. Myers Company, Wright Building
Houston, Texas Representative: Alpha Engineering Company, P. O. Box 12371
Pittsburgh, Pennsylvania Representative: D. D. Foster Company, 501 Alcoa Building
West Coast Representative: Jacobs Engineering Company, Pasadena: RYan 1-9373, Oakland, TEmplebar 2-5391
Illinois Representative: M. B. Fisher, 1521 Courtland Avenue, Park Ridge, Illinois

how much does heater downtime cost?

A 36,000 B/D petroleum refining unit using a 100 million Btu heater upgrades the value of its crude charge roughly $25,000 per stream day. If the heater comes down for any reason only 10 days a year, a loss of a quarter million dollars is chalked up. A gain of 30 operating days in the year can mean a realization of 10% on capital investment which, in a multi-million dollar plant, is a considerable sum.

Downtime is expensive. The purchaser of a heater must as a result look beyond his initial cost to the long pull. For the long pull, Lummus oil heaters have consistently exhibited great durability while operating efficiently and with an absolute minimum of days lost to maintenance work.

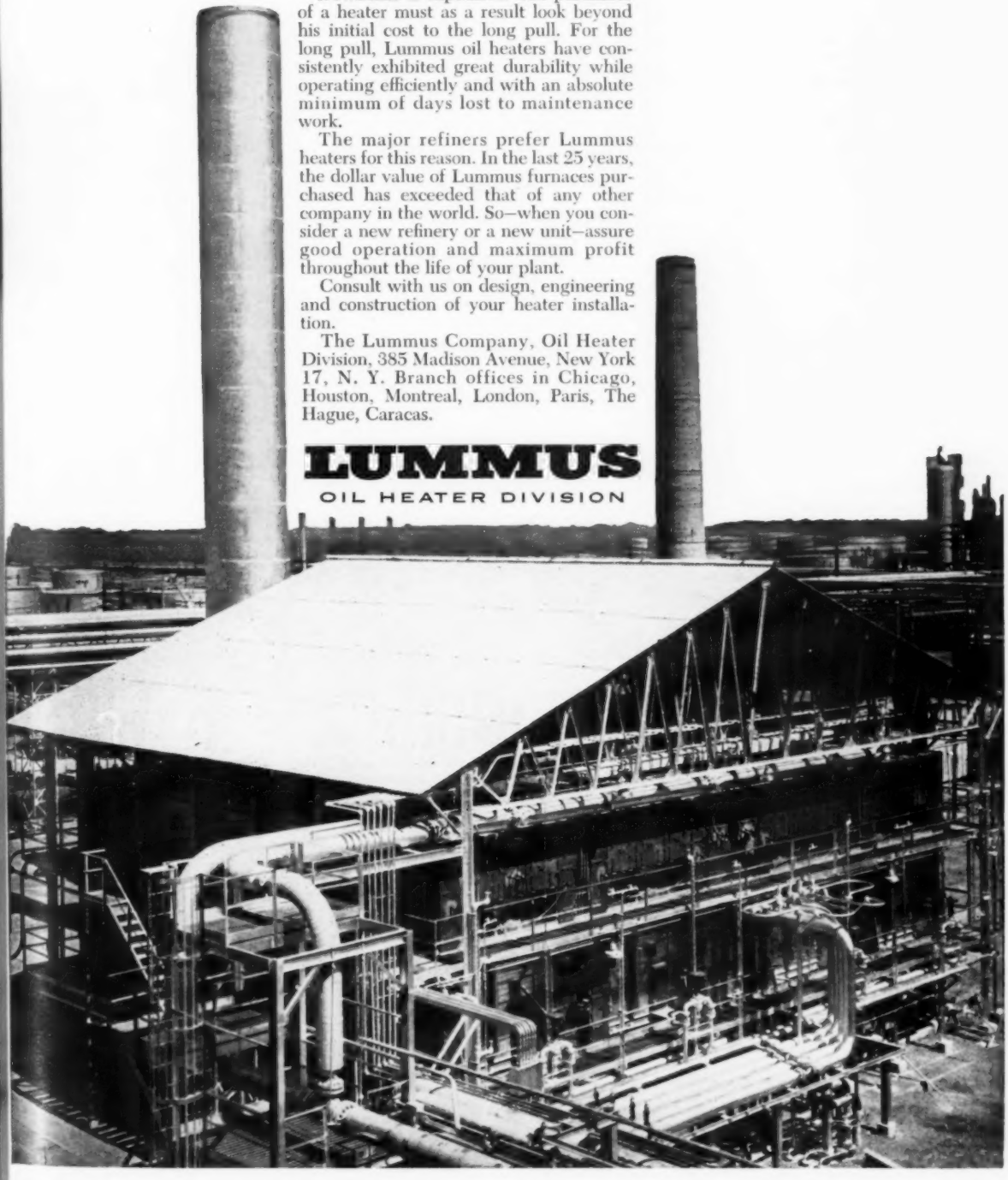
The major refiners prefer Lummus heaters for this reason. In the last 25 years, the dollar value of Lummus furnaces purchased has exceeded that of any other company in the world. So—when you consider a new refinery or a new unit—assure good operation and maximum profit throughout the life of your plant.

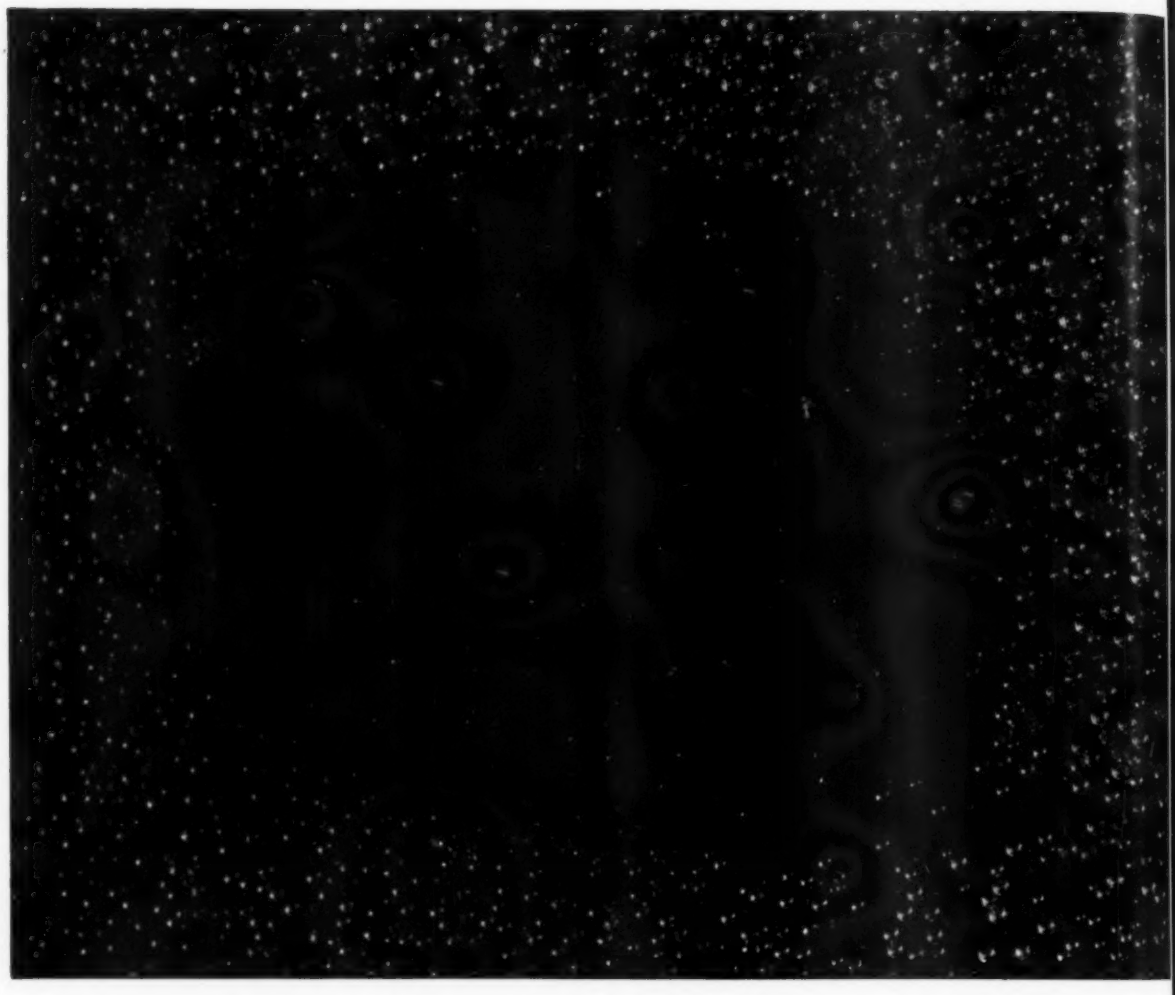
Consult with us on design, engineering and construction of your heater installation.

The Lummus Company, Oil Heater Division, 385 Madison Avenue, New York 17, N. Y. Branch offices in Chicago, Houston, Montreal, London, Paris, The Hague, Caracas.

LUMMUS

OIL HEATER DIVISION





An Inside-Out View

CORROSION INHIBITOR AT WORK

Here's an external view of what takes place internally in refinery equipment. This photograph shows a piece of mild steel. The center has been treated with Polyrad. The entire piece of steel then was immersed in an acidic environment. The tiny bubbles of hydrogen show the beginning of corrosion. But the center portion remains a safety island—thanks to Polyrad.

This photographic impression bears out what most refinery operators already know—that Polyrad is an effective inhibitor. It will economically reduce corrosive damage with an average treatment of about 1 quart of Polyrad per 1,000 barrels of fluid.

Polyrad's powerful detergent action also serves to loosen organic and inorganic deposits, allowing them to be removed in the fluid stream.

All around the refinery, Polyrad can help maintain throughput, increase heat transfer, reduce metal loss, and cut down-time for maintenance. A Hercules technical representative will be glad to explain how Polyrad can be used to combat your specific corrosion problem.

Pine Chemicals Division, Naval Stores Department
HERCULES POWDER COMPANY
INCORPORATED
984 King St., Wilmington 99, Del.

POLYRAD®
FILMING AMINE INHIBITOR

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Petroleum Processing

1st TRADE SHOW IN PRINT 1957

READER SERVICE CARDS

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PETROLEUM PROCESSING
330 WEST 42nd STREET
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FIRST CLASS
PERMIT NO. 64
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New York, N. Y.

BUSINESS REPLY CARD
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4c-POSTAGE WILL BE PAID BY

PETROLEUM PROCESSING
330 WEST 42nd STREET
NEW YORK 36, N.Y.

LESS MECHANICAL CLEANING, MORE ON STREAM TIME WITH UNITS TUBED WITH WOLVERINE TRUFIN® TYPE S/T

Concentration Unit Still On Stream After Two Years

With the passing of each day more and more evidence is accumulating to prove – very conclusively – that condensers and heat exchangers tubed with integrally finned condenser tube stay on stream for longer periods than those using plain tube.

Illustrated at the top right, for example, is the flow sheet of a gas concentration unit at a large midwest refinery. Five of its heat exchangers are tubed with Wolverine Trufin Type S/T–the integrally finned condenser tube. These units consist of a debutanizer bottom cooler, debutanizer overhead condenser (2 exchangers in parallel) and a high pressure cooler (2 exchangers in series).

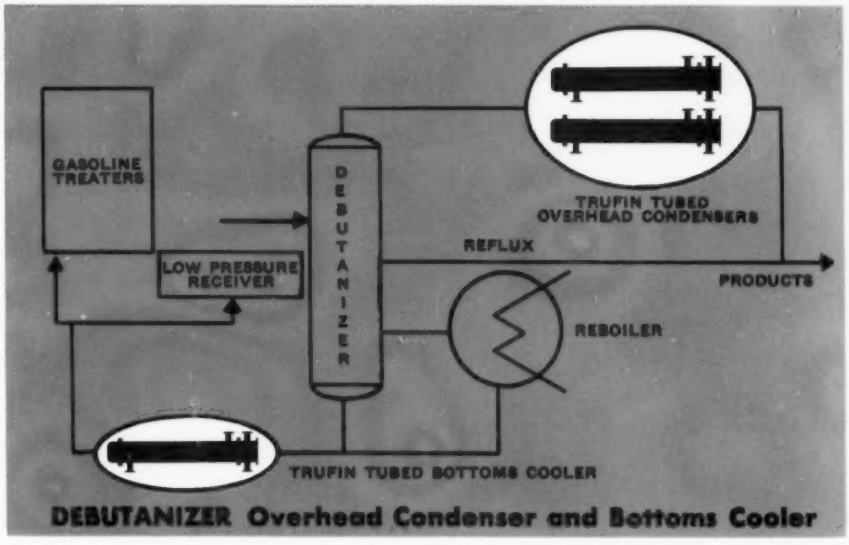
The units (tubed with Trufin Type S/T, ¾" O.D., 16 BWG admiralty brass condenser tubes), have been on stream for two full years without requiring mechanical cleaning on the shell side–and are still going strong.

In establishing the reasons for this resistance to fouling, engineers have discovered that the configuration of Trufin surface is apparently less conducive to scale build-up than bare tube. Scaling tends to follow the contour of the fins and does not accumulate preferentially between the fins but forms an extended projection of the fin. In many cases the tubes appear to be self shedding.

GET VALUABLE BOOK FREE

Detailed breakdowns in cost differentials between prime surface and integrally finned condenser tubes are graphically explained in Wolverine's new book "Comparative Heat Exchanger Costs".

Just off the press, this new book will be invaluable to design and processing engineers alike. It carries complete cost comparisons for the design of new heat exchangers and condensers as well as for the retubing of existing equipment. Write for your FREE copy.



DEBUTANIZER Overhead Condenser and Bottoms Cooler

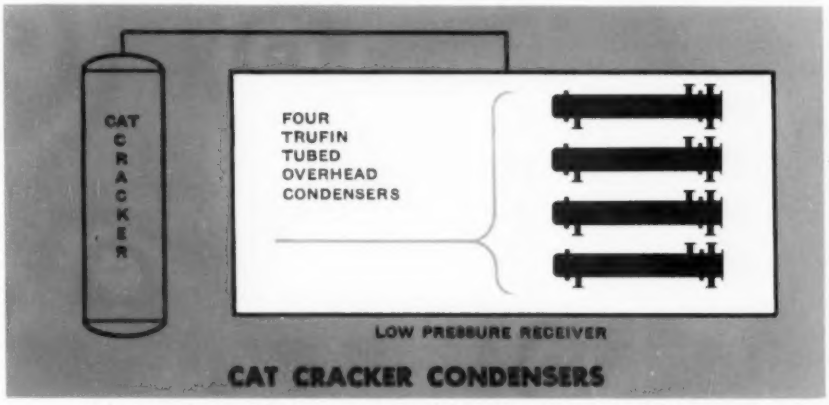
Trufin-Tubed Units For Cat Cracker Still Going Strong After Three Years

Still another authenticated example of outstanding performance by Wolverine Trufin Type S/T is found in the catalytic cracking unit of this same refinery.

This operation consists of four Trufin-tubed heat exchangers used in condensing-subcooling service for taking overhead vapors from the "cat" crackers. These exchangers have been on stream continuously for three years and to date have not required mechanical cleaning on the shell side.

In addition to increasing on stream time, Wolverine Trufin Type S/T also boosts heat transfer performance. Because of its extended surface, Type S/T has approximately 2½ times more surface area than does plain tube. The result is more BTU's extracted per foot of tube.

It is because of such features, for example, that the engineers in this particular refinery specify Wolverine Trufin Type S/T whenever possible. At present their use of Type S/T totals more than 100,000 linear feet.



CAT CRACKER CONDENSERS

Wolverine Trufin is available in Canada, through the Unifin Tube Company, London, Ontario.

CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1441 CENTRAL AVE., DETROIT 9, MICH.

Manufacturers of Copper Seamless Tubing and Condenser Assemblies

Plants in Detroit, Michigan, and Decatur, Alabama. Sales Offices in Principal Cities
EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.

TUBEMANSHIP:

Means Top-Flight Condenser Tubing for Chemical and Petroleum Industries

By Ernest Dodd

Have you ever visited a modern tube mill—such as either of those operated by Wolverine Tube in Detroit, Michigan or Decatur, Alabama? It's quite an experience to see piercing mills, extrusion presses and giant draw benches producing gleaming aluminum and copper tube.

It's quite an experience also to talk to Wolverine employees – from the top brass in the front offices to the men that man the machines. It isn't long before you realize that here are men with great pride and single purpose in their work. You begin to recognize a certain something that they all have in common.

You discover that this mysterious "something" has a different meaning to everyone with whom you speak. To the setup man, for example, it's the delicate touch with which he adjusts a machine, while an inspector will tell you that its the care with which he examines finished tube before releasing it to the customer.

The sales group will tell you it's the completeness of the product line while a plant manager will say that it's made up of facilities . . . things like plants and machines and manufacturing processes.

And, as you talk to all these people, something suddenly clicks . . . becomes crystal clear. You know what a Wolverine man or woman means when they mention "Tubemanship". It's a word that can be described differently by different people—yet have the same meaning to all.

Actually it's the same individual pride – deep within its people – that has made America and American industry great. At Wolverine they call it Tubemanship. It is your assurance of the finest tubing it is possible to make.

WOLVERINE HAS COMPLETE CONDENSER TUBE LINE-UP

Processing engineers can specify Wolverine condenser tubing to meet every type of operating condition.

Wolverine prime surface tube, for example, is available in a wide range of sizes and alloys in both copper, copper-base alloys and aluminum. If increased heat transfer capacity is a must, engineers can specify Wolverine Trufin®—the integrally finned condenser tube. Trufin is available in five distinct types with various fin spacings and heights. Depending on type, it can be specified in many sizes and alloys in copper, copper-base alloys, aluminum and electric-welded steel.

Where corrosion on both sides is encountered, Wolverine Duplex, in either integrally finned or prime surface form, can be specified. To speed re-tubing operations and reduce condenser tube inventories, Wolverine U-bend condenser tubes are recommended. These prefabricated condenser tubes are shipped in the exact order of their installation in disposable box-type pallets.

FREE ENGINEERING HELP

Ready at all times to help customers solve tubing problems are the highly skilled members of Wolverine's Field Engineering Service. These tubing technicians will come up with the right answers to such tubing and heat transfer problems as corrosion, design, applications, etc. Next time you have a tubing problem – don't hesitate – ask for the services of a Wolverine Field Engineer.

WRITE FOR THIS NEW BOOK

The story of Wolverine Tube – its employees, facilities and products – graphically told in Wolverine's newest book "The Measure of Tubemanship". Write today for your free copy.

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WOLVERINE TUBE DIVISION
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER COMPANY
CALUMET & HECLA OF CANADA LIMITED
CANADA VULCANIZER AND EQUIPMENT COMPANY LIMITED

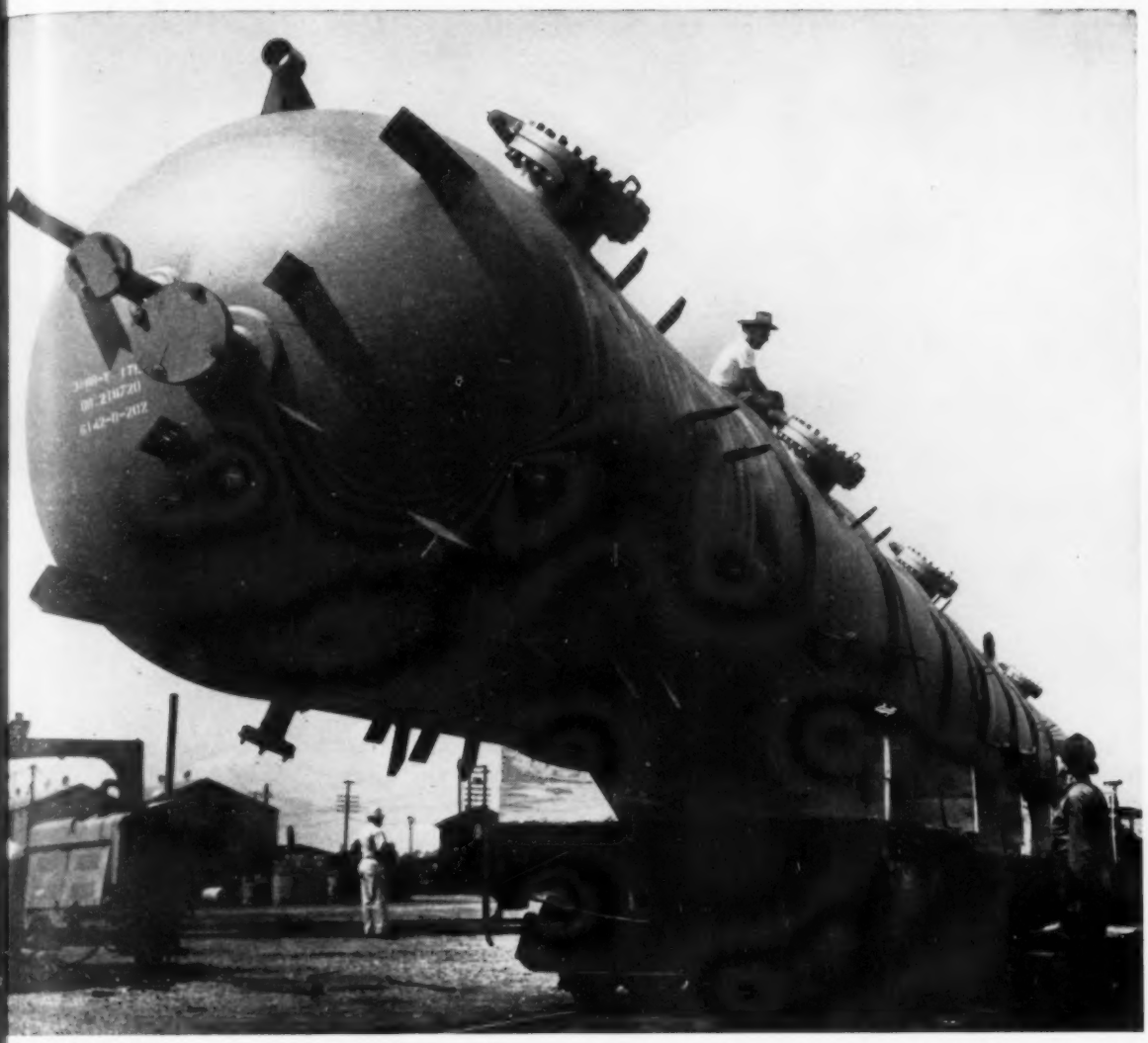
WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1441 CENTRAL AVE., DETROIT 9, MICH.

Manufacturers of Quality Condenser Tubing and Extruded Aluminum

Plants in Detroit, Michigan, and Decatur, Alabama. Sales Offices in Principal Cities

EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

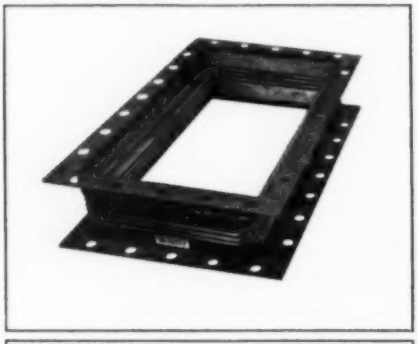
In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

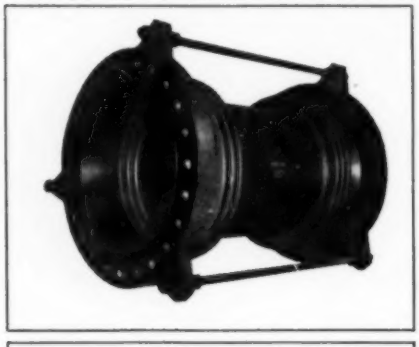
Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

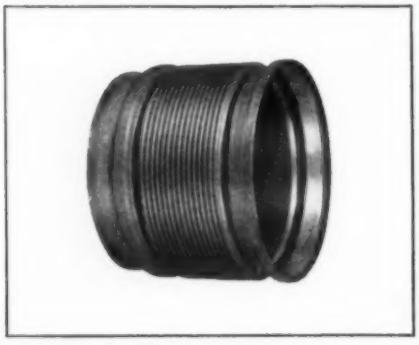
Engineers—Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

(To obtain more data on advertised products see page 280)







SOLA-FLEX®

EXPANSION JOINTS AND BELLOWS ARE MADE IN ALL SIZES AND VARIETIES

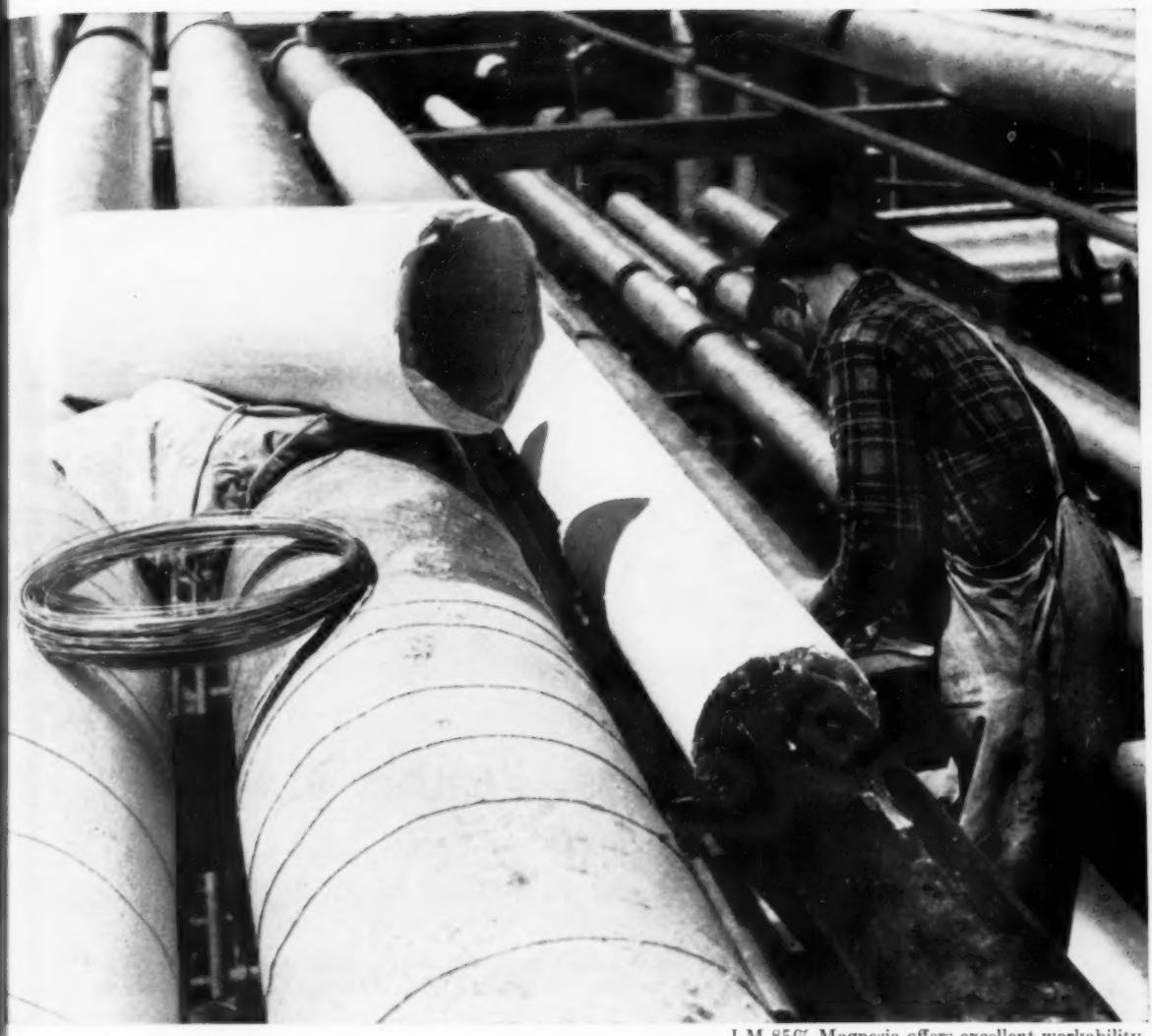
Write for Catalog

THE SOLA-FLEX LINE is the most comprehensive in the world. It includes many basic types of expansion joints—convoluted, U-span, rectangular, and others. Sizes range from ½ in. to 35 ft in diameter. Pressure ranges run from complete vacuum to standard 900 psi test and to higher pressures on special designs. Bellows have been built for service from −300 F to 2000 F. Materials used include all types of steels and a variety of high alloys.

Pipe expansion problems increase with higher pressures, temperatures and smaller space. Sola-Flex joints provide the answer—with economy and efficiency. Write for catalog today. Dept. D-16, Solar Aircraft Company, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS OF GAS TURBINES · AIRCRAFT AND MISSILE COMPONENTS · BELLOWS · CONTROLS · HIGH TEMPERATURE COATINGS · METAL ALLOY PRODUCTS.



J-M 85% Magnesia offers excellent workability, ease of application, accurate temperature control.

Make your next maintenance job less costly...yet measurably more effective...with Johns-Manville 85% Magnesia!

At temperatures to 600F, no insulation is so widely used, or so closely associated with economy and increased operating efficiency as 85% Magnesia. Any wonder, then, that 71% of insulation maintenance engineers responding in a recent survey made 85% Magnesia their first choice in its temperature range.

There's good reason for this overwhelming acceptance. In petroleum maintenance, for example, the material's durability, low conductivity, and structural strength are particularly advantageous in both initial application and during operation.

Lightweight and readily workable, J-M 85% Magnesia assures fast, easy application. In operation it provides the ultimate in insulating value—long life—virtually no replacement—and the very minimum of maintenance.

To assure you maximum value in insulation application, Johns-Manville offers you complete planning and job-site service . . . practical recommendations by the world's most experienced insulation engineers . . . plus expert installation by Johns-Manville Insulation Contractors.

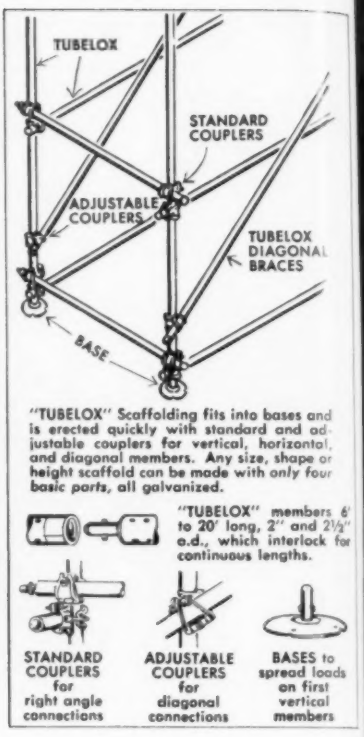
Write today for further information on Johns-Manville 85% Magnesia Insulation. Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, 565 Lakeshore Road East, Port Credit, Ontario.

JOHNS-MANVILLE PRODUCTS

Johns-Manville INSULATIONS FOR LASTING THERMAL EFFICIENCY

MATERIALS • ENGINEERING • APPLICATION

"TUBELOX" SCAFFOLDING assembles quickly for work on alkylation tower.


TUBELOX
STANDARD COUPLERS
ADJUSTABLE COUPLERS
TUBELOX DIAGONAL BRACES
BASE
"TUBELOX" Scaffolding fits into bases and is erected quickly with standard and adjustable couplers for vertical, horizontal, and diagonal members. Any size, shape or height scaffold can be made with only four basic parts, all galvanized.
"TUBELOX" members 6' to 20' long, 2" and 2½" o.d., which interlock for continuous lengths.
STANDARD COUPLERS for right angle connections
ADJUSTABLE COUPLERS for diagonal connections
BASES to spread loads on first vertical members

Saving Turn-Around Time

How one large refinery does it with "TubeLox" Scaffolding

SAVING turn-around time for refinery maintenance and repair duty is an all-important factor. Many hours can be saved if scaffolding and work platforms are provided that can be erected, dismantled and moved with the utmost speed, efficiency and safety.

A large midwestern oil company uses "TubeLox"® Steel Scaffolding because it performs as required. It makes no difference what the turn-around jobs are—cracking, cooling or crude distillation towers; pressure vessels; heat exchangers; tanks, valves or piping—"TubeLox" Scaffolding works perfectly for all.

This versatile, all-purpose scaffolding, galvanized throughout to resist corrosion, is unlimited in its ability to conform to almost any shape, size or height encountered. There are virtually no obstructions which can not be overcome with "TubeLox" Scaffolding . . . even inside of tanks.

Towers and associated piping can be scaffolded with "TubeLox" Scaffolding to provide working platforms at any desired levels. It is fireproof and requires only a minimum amount of wood for staging. The strong, slender members offer little wind resistance and can be combined with "TubeLox" Aluminum End Frames, with built-in ladders, for extra light-weight, easily-handled rolling or stationary scaffolds of medium height.

Another important consideration given to "TubeLox" Scaffolding by this refinery is the fact that all components are 100% recoverable after each use and provide many years of practical, economical service.

"Trouble Saver"® Sectional Steel Scaffolding with standard frames varying from 3' high x 5' wide to 6'6" x 5', together with pivoted, diagonal braces, are often used for intermediate rolling or stationary platforms in refinery maintenance. "Gold Medal"® Midget and Junior Safety Swinging Scaffolds suspended by steel cables help in speeding the completion of light-duty repairs. The light-weight, ease-of-handling qualities of PS aluminum scaffolds save time and labor on many isolated turn-around jobs.

It would pay you to get the facts on how "TubeLox" and other PS Co. Scaffolding can help you save turn-around time. PS Co. offers complete nation-wide engineering service available locally. See the Yellow Pages in your telephone directory for the nearest Patent Scaffolding Co. office or representative that *sells* or *rents*" TubeLox" or "Gold Medal" Scaffolding.

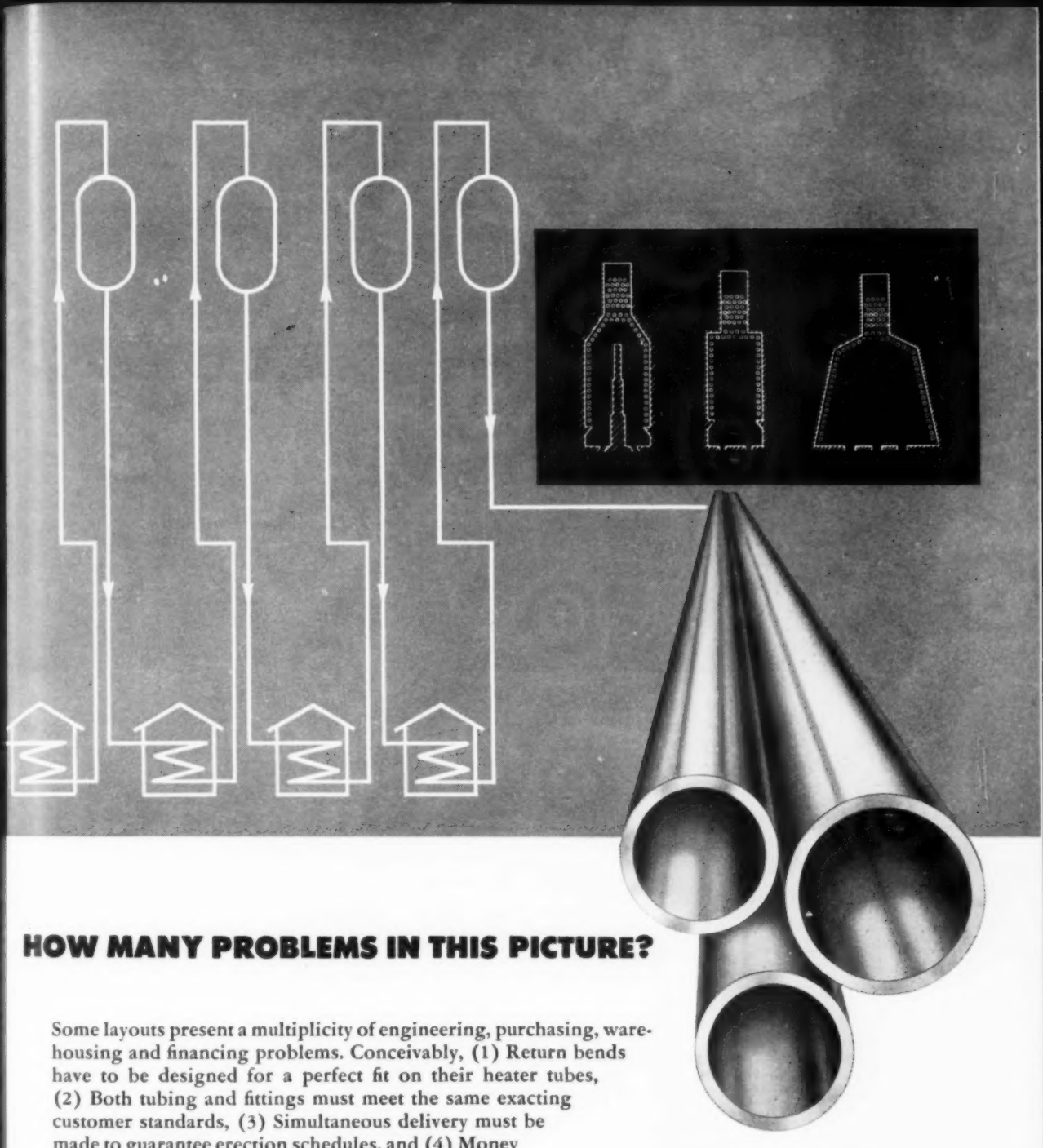
For complete description and installation details . . . write for Bulletins PTS-18 and PTS-19.

FOR GREATER SAFETY...EFFICIENCY...ECONOMY

GOLD MEDAL LADDERS SCAFFOLDING®

THE PATENT SCAFFOLDING CO., Inc.

38-21 12th Street Dept. PP Long Island City 1, N. Y.
***West Coast:* 6931 Stanford Ave., Los Angeles 1, Calif.**
Branches in all principal cities
***In Canada:* 355 Dufferin St., Toronto**



HOW MANY PROBLEMS IN THIS PICTURE?

Some layouts present a multiplicity of engineering, purchasing, warehousing and financing problems. Conceivably, (1) Return bends have to be designed for a perfect fit on their heater tubes, (2) Both tubing and fittings must meet the same exacting customer standards, (3) Simultaneous delivery must be made to guarantee erection schedules, and (4) Money tied up in material in process at any one time must be kept to a minimum.

In such a situation, it's best to depend upon Mr. Tubes for coordinated delivery of perfectly matched tubing and fittings.

Think of your own requirements in terms of the right tube for the job, tubing (or alloy pipe) and welding fittings and forged steel flanges as components of an integrated system—and you'll make B&W's Mr. Tubes a member of your team. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W
TUBULAR PRODUCTS DIVISION

TA-6085-PP

Seamless and welded tubular products, seamless welding fittings and forged steel flanges in carbon, alloy and stainless steels

Forged Steel. Shot Blasted. All Phoenix flanges meet full A.S.A. specifications — carbon steel and alloy.

Spot faced bolting surfaces, extra fine facings, accurate threading and a protective coating are typical of Phoenix quality.

Precisely machined welding bevel.

Special facings, bores, drilling, threading and special machining available.

The long life and precision workmanship you have a right to expect in the flanges you buy are assured when you order Phoenix forged steel flanges. You simply can't buy a better flange! It costs no more for Phoenix quality and *service*. That's why it's always worthwhile discussing your pipe flange requirements with the Phoenix representative.

A serrated gasket surface finish is standard on all Phoenix flanges with raised facings.

Write for handy 36 page pocket-size reference booklet containing useful data on flanges. It's FREE!

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

PHOENIX

FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. · JOLIET, ILL. · FOUNDED 1862

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, RUBBER PRODUCTS DIVISION, OIL AND GREASE SEAL DIVISION

Yes, Virginia, gasoline does cost less than it did 30 years ago. (Before taxes, of course.) Most oilmen know this story; we know how the power in regular gasoline has climbed from 50 octane in the mid '20s to over 90 today. We know, too, what a fantastic value gasoline represents as a commodity. An industrial worker labored 23 minutes to buy a gallon in 1926; today he works just 6½ minutes for a better product. *We* know—but the public does not. What are *you* doing to tell them? **SHELL OIL COMPANY**

 (To obtain more data on advertised products see page 280)

This is one of Purolator's new porous metal filters designed for high temperature applications (up to 1000°F), and for highly corrosive fluids. It can take flow rates comparable to any high temperature filter in existence with lower differential pressures and a better degree of filtration, and is recommended for the atomic, guided missile, aircraft, chemical, petroleum, industrial and food fields.

New Purolator Filters for high temperature applications

A new porous metal filter has been perfected by Purolator to handle gas streams up to 1000°F. It is ideal for a number of applications in petroleum cracking – such as the removal of finely divided catalyst from the gaseous product stream of a petroleum catalytic cracking unit. Another is in the recovery of products which are finely divided particles and are being exhausted along with gas streams from the process.

The one-piece porous element can remove particles as small as one micron in size from a wide range of fluids, including such corrosive materials as nitric acid, hydrochloric acid, sulphuric acid, phosphoric acid and strong alkalies. It is made in a variety of diameters and lengths, and its radial fin construction can be supplied in specified depths and numbers of convolutions to give extended area within confined space. Varying flow rates are also available. Filters of stainless steel, monel, nickel and other metals can be made as required.

Controlled permeability and uniform porosity are other advantages of the new filter. They can be varied as to pore size desired. The filter has a higher degree of porosity per square inch than is available in any other high temperature, metallic filter element. It can handle differential pressures of up to 500 pounds per square inch.

Send in your problem — Dept. SI-530.

Filtration For Every Known Fluid

PUROLATOR

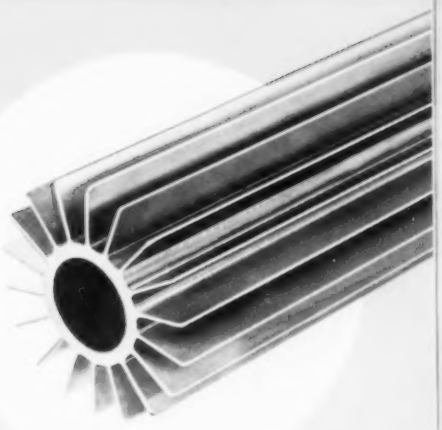
PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

There is one type of

HEAT TRANSFER SURFACE

best suited to your next heat exchanger.

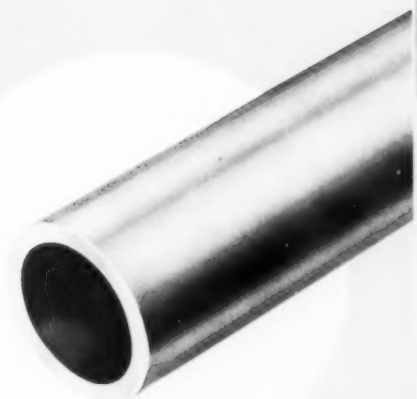


G-R can impartially and authoritatively tell you which

In some cases, *bare tubes* may be the most practical type of heat transfer surface for your needs. In other cases, *finned tubes* may provide a more efficient and compact exchanger.

G-R builds heat transfer apparatus with *either* bare tubes or finned tubes. G-R finned tube surfaces include both longitudinal G-Fin and helical K-Fin . . . two widely popular types that have proved their superiority in hundreds of thousands of installations throughout the world.

G-R builds both shell-and-tube units and open sections . . . for large or small capacities . . . for high or low temperatures and pressures . . . for clean or clogging fluids, with high or low heat transfer rates. Your problem involves some of these conditions. G-R engineers have met all these conditions in all of their combinations. Let us advise you. Call in a G-R representative today.



THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO

HERE'S AN EXAMPLE OF G-R LEADERSHIP IN HEAT TRANSFER APPARATUS

Name your test for heat exchangers

and apply it to

G-R Twin G-Fin Sections

Is it the DESIGN test?

G-R Twin G-Fin Sections are the simplest form of heat exchanger—a pipe within a pipe, with head end closure consisting of only 4 parts.

Is it the ADAPTABILITY test?

More than 80,000 G-R Twin G-Fin Sections are in use on a wider range of heat transfer services than any other design of heat exchanger on the market.

Is it the BACKGROUND test?

G-R Twin G-Fin Sections have been on the market for 25 years, and their design and construction are based on 90 years of experience in building heat transfer apparatus.

Is it the PERFORMANCE test?

Many thousands of G-R Twin G-Fin Sections have been in service for 10 years and longer with negligible maintenance cost and without replacements of any kind.

Is it the EFFECTIVENESS test?

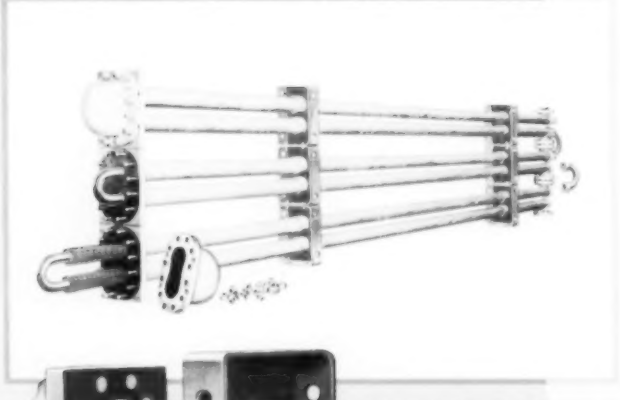
The G-R Twin G-Fin Section has elements with longitudinal G-Fins that have 6 to 8 times the external transfer surface of bare tubes, thereby permitting fewer tubes to handle services in which the two fluids have unequal heat conductivity.

Is it the RATING test?

The long and extensive experience of the G-R engineers in heat transfer, and the operating results of the many tens of thousands of G-R Twin G-Fin Sections in service assure ratings which are authoritative and dependable and can be guaranteed.

Is it the CONVENIENCE test?

G-R Twin G-Fin Sections are standard and interchangeable. They are easily handled, can be shifted from one kind of heat transfer service to another, can be installed in series or parallel to suit the desired capacity and temperature range, and sections can be added or removed to meet changes in operating conditions.

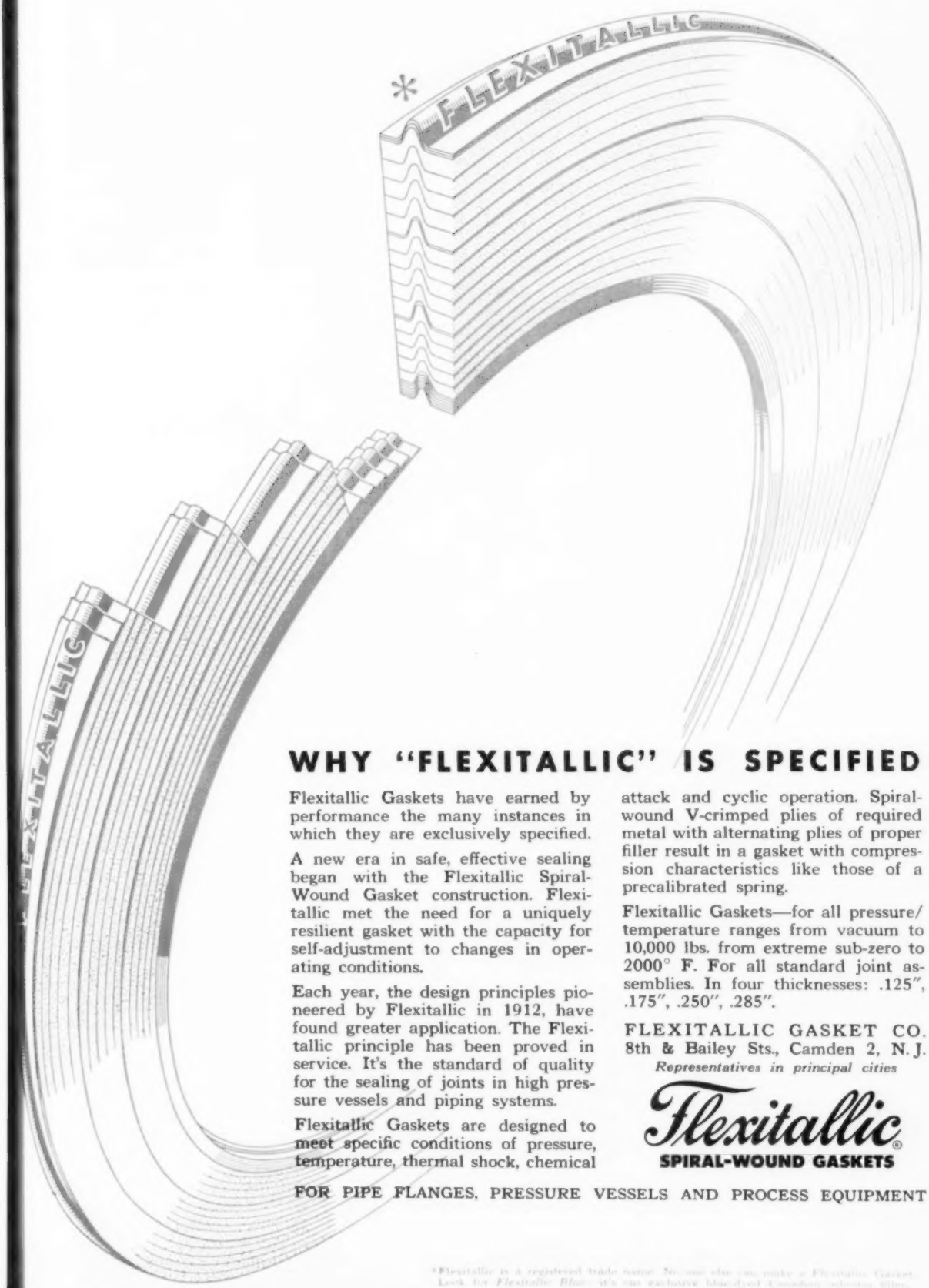


Write for bulletin describing these "universal" heat exchangers in detail.

THE GRISCOM-RUSSELL CO.

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

MASSILLON, OHIO



WHY "FLEXITALLIC" IS SPECIFIED

Flexitallic Gaskets have earned by performance the many instances in which they are exclusively specified.

A new era in safe, effective sealing began with the Flexitallic Spiral-Wound Gasket construction. Flexitallic met the need for a uniquely resilient gasket with the capacity for self-adjustment to changes in operating conditions.

Each year, the design principles pioneered by Flexitallic in 1912, have found greater application. The Flexitallic principle has been proved in service. It's the standard of quality for the sealing of joints in high pressure vessels and piping systems.

Flexitallic Gaskets are designed to meet specific conditions of pressure, temperature, thermal shock, chemical attack and cyclic operation. Spiral-wound V-crimped plies of required metal with alternating plies of proper filler result in a gasket with compression characteristics like those of a precalibrated spring.

Flexitallic Gaskets—for all pressure/temperature ranges from vacuum to 10,000 lbs. from extreme sub-zero to 2000° F. For all standard joint assemblies. In four thicknesses: .125", .175", .250", .285".

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 2, N. J.
Representatives in principal cities

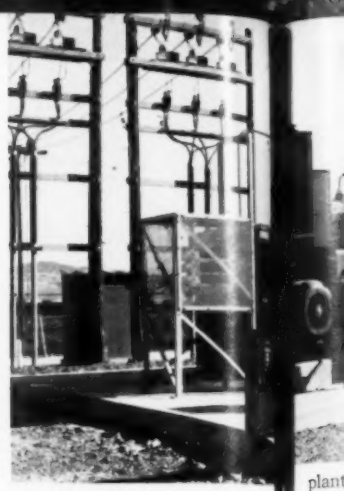
Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue dye of Canadian asbestos filler.

(To obtain more data on advertised products see page 280)

BUILT IN 14 MONTHS by The M. W. Kellogg Co., new ammonia plant is a unit of Standard's Richmond refinery, one of West's largest. All electric equipment is by General Electric, which also provided engineering service to help achieve fast start-up.

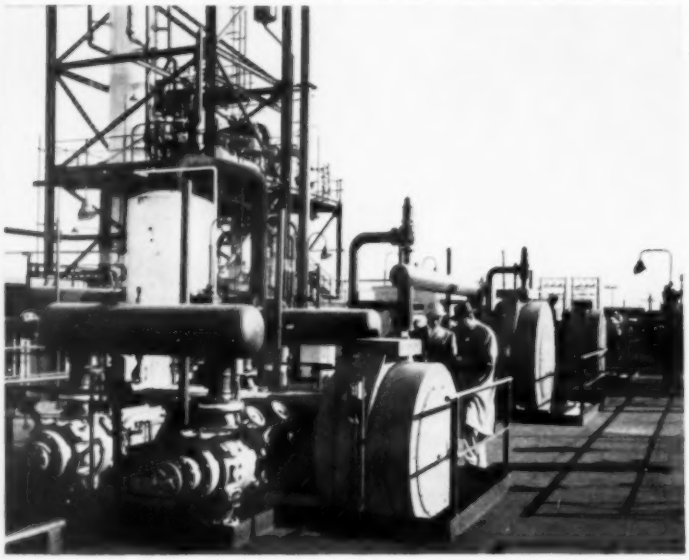


CO-ORDINATED for top reliability, G-E equipment in master substation for ammonia

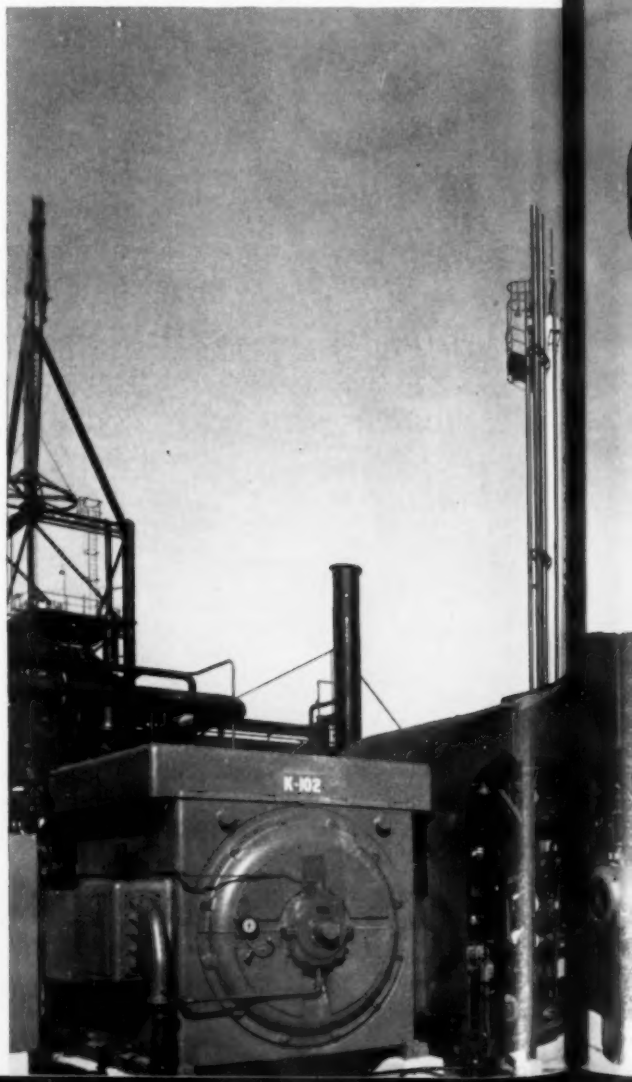
At Standard's Richmond, Calif., refinery . . .

General Electric engineering services help

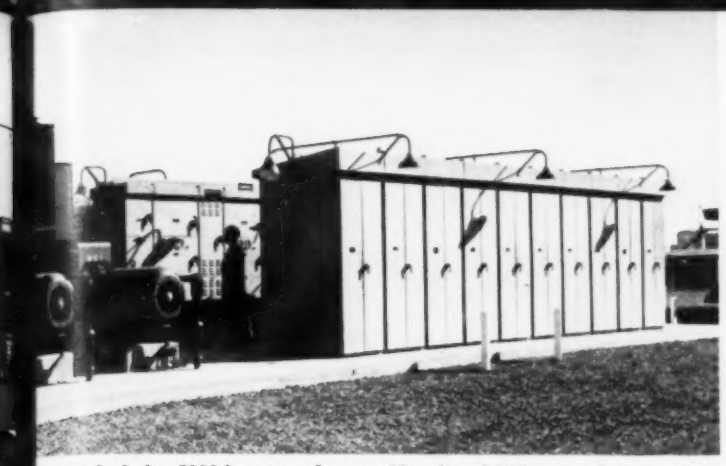
OUTDOOR-LOCATED on platform to drive compressors are 8 high-efficiency, enclosed, force-ventilated G-E synchronous motors (3 shown) with excitation obtained from substation's d-c m-g sets.



PLANT'S BIGGEST, a 4000-hp 12,000-v totally enclosed force-ventilated G-E induction motor drives synthesis gas compressor. Explosion-proof 60-hp G-E motor (r.) drives blower



WEATHER-PROTECTED, 2 rugged 350-hp G-E induction motors drive cooling-water pumps. Other plant induction motors are either enclosed force-ventilated or explosion-proof, fan-cooled. ▼



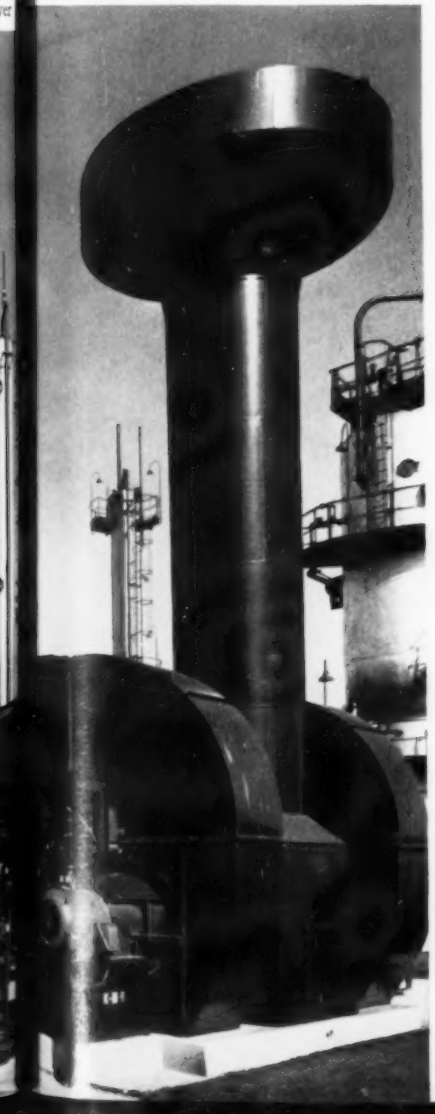
plant includes 5000-kva transformer, 17 units of 12-kv metal-clad switchgear, 2300-v Limitamp* motor starters, 480-v outdoor motor control centers, 2 outdoor motor-generator sets, and two 480-v transformers.

*Registered trade-mark of General Electric Co.

EASY MAINTENANCE of plant's G-E metal-clad switchgear is shown by workman removing vertical-lift, magne-blast circuit breaker for inspection.

speed opening of 300-ton/day ammonia plant

drawing clean air—via black ductwork and mushroom tower—from upper level of uncontaminated atmosphere.



General Electric power system, installed to meet rigid construction schedule, helps plant get fast start on profitable production

Standard Oil Company of California, Western Operations, Inc., recently added to its Richmond, California refinery—the largest west of the Rockies—a new $11 million ammonia plant designed, engineered and built by The M. W. Kellogg Co. The plant's capacity of approximately 300 tons per day of anhydrous and aqueous ammonia is shipped to nearby California Spray Chemical Corp., a subsidiary, for conversion into fertilizer.

GENERAL ELECTRIC supplied the new plant's electric equipment—compressor drives, auxiliary motors, and complete outdoor substation with co-ordinated components. In addition, General Electric engineering services helped both customer and designer get the new plant from the discussion stage to on-stream in only 14 months.

An example was the contribution of General Electric installation and field service engineers. By supervising the installation of the electric equipment as scheduled deliveries arrived, they helped reduce field installation costs, speed completion of construction schedules, and hasten start-up time. To Standard, this meant getting into production faster, and thereby, showing a return sooner on the large capital investment tied up in the plant.

IN ADDITION, the 17,000-kva block of power will be integrated into the existing plant system. General Electric application engineering services, working closely with Standard and Kellogg representatives, helped provide the electrical equipment co-ordination and integration necessary to meet the plant's process power requirements.

For *your* new chemical plant, too, General Electric offers a one-manufacturer source of quality electric equipment and valuable engineering services to help provide you and your process contractor with an efficient, co-ordinated electrical system. Early in your planning, contact your nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y. 662-49

Engineered Electrical Systems for the Process Industries

GENERAL ELECTRIC

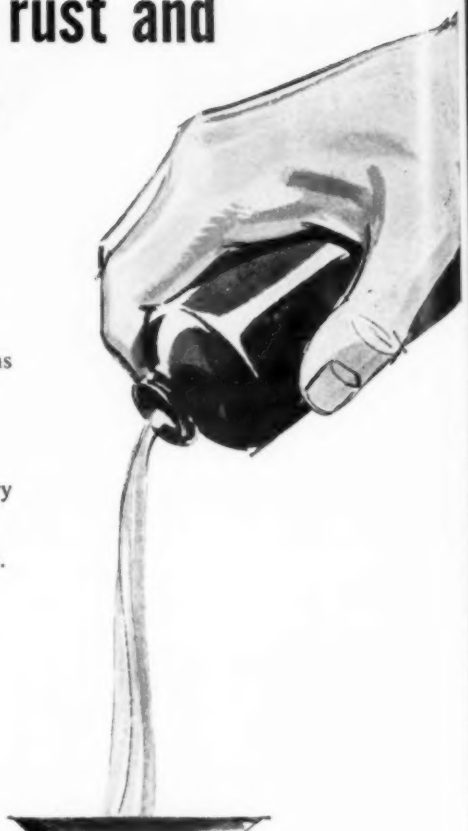
Pipeline protection from rust and corrosion costs so little with **UNICOR**®

The pipeline operators who use Unicor, UOP's oil-soluble corrosion inhibitor, not only get dependable protection but get it at surprisingly little cost. Such minute concentrations are required that Unicor's cost is only about $0.0005/bbl. of pipeline product.

Actually, only one molecule of Unicor is required for every million molecules of gasoline. Additional savings, too, from much reduced scraper cleaning and filter replacement costs.

Unicor is completely dependable. It prevents rusting in product pipelines at a typical concentration of 10 ppm. Addition is required at only one point and since it is distributed uniformly over the entire internal surface, protection is virtually 100% effective.

The services of our technical specialists are available to assist you in the design, installation and operation of a Unicor system of protection. Write us for samples and information.

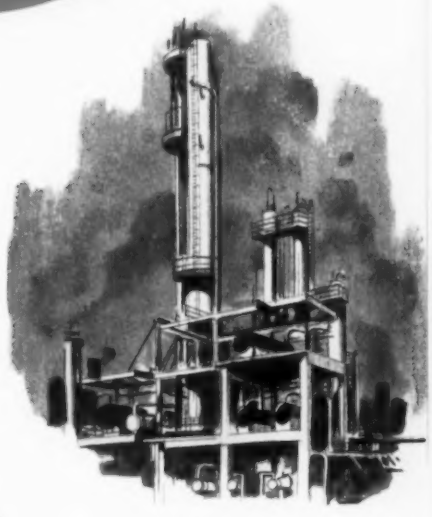


PRODUCTS DEPARTMENT
UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U. S. A.

Consistency

is TRADITIONAL at WESTERN

Consistency is vital to HF ALKYLATION



In this commercial use of hydrofluoric acid as a catalyst for the alkylation of olefins with isobutane, *consistent high quality of product* is of paramount importance in this well-established process.

HF Alkylation for the production of high octane motor fuel blending components demands *equal consistency* in the performance of the heat transfer equipment used to cool the reacting streams.

Western Heat Exchangers are characterized by consistency throughout their design and manufacture—from initial rating to completed fabrication.

Whatever the heat transfer requirement of your process, a proposal from Western should be your first consideration.

Water cooling of reacting streams is being efficiently handled by Western exchangers in many HF Alkylation units currently in operation.
There is a Western representative ready to serve you—**today.**

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY
P.O. Box 1888 – Tulsa, Oklahoma

An experienced source for Process Stream Analyzers

MSA's quality control check-
gas analyzers for dependable

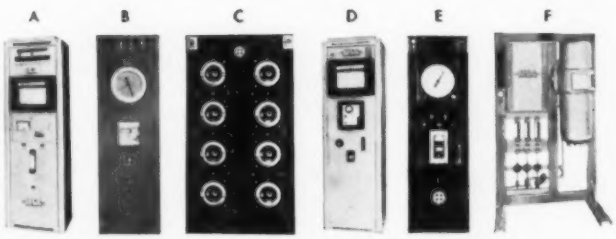
We feel strongly about this operation in the production of our gas analyzers. It's called the Quality Control Check-Out, which is just another way of saying it's our final once-over to make sure the customer gets what he ordered.

It sounds routine, but it isn't. Thirty years in the business of gas analysis instrumentation has given us a rigid check-list for measuring the accuracy and performance of every MSA instrument. We feel this preoccupation of ours with production quality is a good part of the reason why more and more people engaged in process stream control are favoring instruments with the MSA nameplate.

You'll find a line-up of our basic instruments at the right. These units are currently improving product quality, lowering processing costs and increasing safety throughout industry. We will be happy to have an Instrument Specialist call, or send you literature.

ighly trained personnel from MSA's Instrument Division tailor a wide variety of MSA gas analyzers to individual customer specifications.

k-out readies these
e on-stream analysis



A. M-S-A (LIRA) Infrared Analyzer
B. M-S-A Hydrogen Sulphide Recorder
C. M-S-A Combustible Gas Analyzer
D. M-S-A Gas Thermatron
E. M-S-A Oxygen Indicator
F. M-S-A Water Vapor Recorder

INSTRUMENT DIVISION

MSA

MINE SAFETY APPLIANCES COMPANY
Pittsburgh 8, Pennsylvania

CATFORMING

YOUR LOW-COST KEY TO HIGH OCTANES

CATALYSTS — Specific type for your problems.

SELECTIVITY — Superior yield at high octanes.

STABILITY — High activity with long life.

DURABILITY — Tolerance for moisture and nitrogen.

REGENERATION — To extend normal life or recover from upsets.

For further information on Catforming, write or wire The Atlantic Refining Company, P. O. Box 8138, Philadelphia 1, Pennsylvania.

it's the **CATALYST** that counts

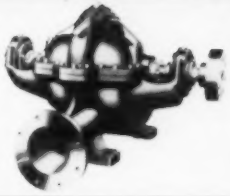
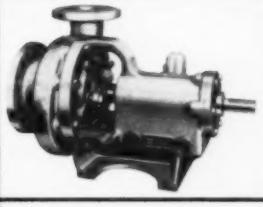
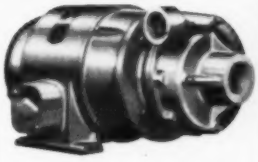
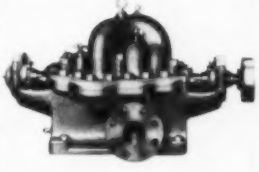
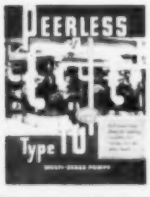
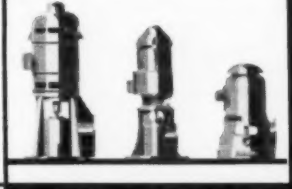
ATLANTIC

5 Peerless Pump Designs

that squarely meet every

LIQUID HANDLING REQUIREMENT

PEERLESS PUMPS

THESE ARE THE *Pumps*	ASK FOR *FREE* ENGINEERING BULLETINS
TYPE A AND TYPE AS GENERAL PURPOSE PUMPS Use these pumps in the widest range of water handling services. Single stage, horizontal split case design. Mechanical shaft seal construction available in sizes up to 4" (Type AS). Heads: up to 300 ft.; capacities up to 70,000 gpm.	 Ask FOR BULLETIN B-1300 & B-1350
TYPE DL AND DM CHEMICAL PROCESS PUMPS Combine quality with economy through a practical idea of component interchangeability between pump types. Oil and grease lubricated bearing housings. Packing gland or shaft seal designs. Air or water cooled back plates. Heads to 430 feet; capacities to 800 gpm. Pressures to 400 psig.	 Ask FOR BULLETIN B-1608
TYPE PE AND TYPE PB END-SUCTION PUMPS America's broadest line of economical, general purpose pumps. Horsepower range from ¼ to 150. Head range to 260 ft. Capacities up to 5500 gpm. Easy to buy, apply, install and maintain. Tens of thousands in use.	 Ask FOR BULLETIN B-2300
TYPE TU AND TYPE TUT MULTI-STAGE PUMPS 2,3,4 and 5-stage designs for supplying, circulating and boosting water and other liquids in moderate capacities against medium and high heads. Durable and dependable in operation. Heads up to 1660 feet; capacities up to 3000 gpm.	  Ask FOR BULLETIN B-1400
VERTICAL INDUSTRIAL SERVICE PUMPS Heavy duty, extra heavy duty and process service types for application to cooling tower service, tank pumping, etc. One of the proudest lines manufactured. Save on piping, always primed, require minimum floor space. Heads to 1000 feet; capacities: 30 to 40,000 gpm. HP range: up to 2500 h.p.	 Ask FOR BULLETIN B-505

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(To obtain more data on advertised products see page 280)

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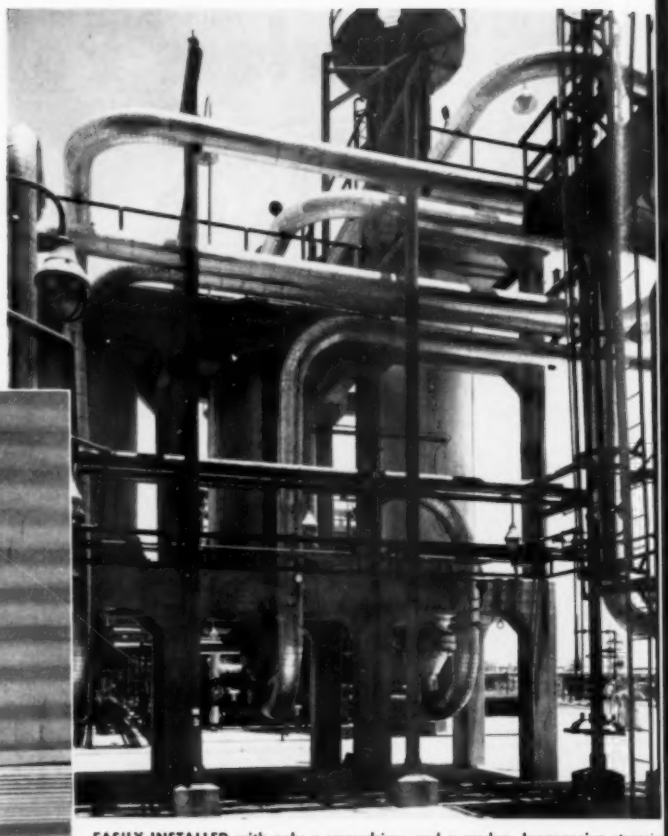
Protects Your Insulation Investment



EASILY INSTALLED with only a screwdriver and a wedge. Inexpensive strapping holds Childers Jacketing securely, yet permits easy removal for inspection of the lines. Same jacketing can then be reapplied without waste.

...safeguards insulation on process lines in thousands of refineries and chemical plants

It's a fact that you benefit from world-wide experience when you protect costly insulation on lines, towers, vessels and tanks with Childers Aluminum Jacketing. More than 2,000 petroleum refining, petrochemical and chemical plants endorse your decision to use Childers Jacketing.

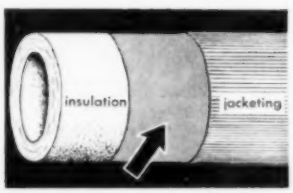
Childers' experience in protecting insulation has provided the most complete line of permanent-type weatherproofing offered today. Five weights of aluminum are available. In addition, time-saving Lap Seal (patent pending), factory-attached moisture barrier and rolled-in cross-corrugation give superior protection and reduce costs.

The initial cost is lower for Childers Jacketing than any other permanent weatherproofing . . . even lower than some temporary coverings. But the biggest savings are in the maintenance-free years following installation. Costly insulation is effectively protected against weather damage and physical abuse.

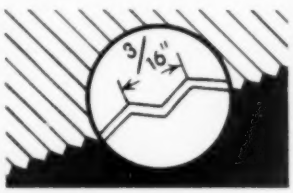
Improved appearance of your plant and easier "housekeeping" are "plus" benefits of Childers Aluminum Jacketing.

Childers Engineering Representatives give professional advice on insulation jacketing in all major industrial centers. Send for a free **sample** of jacketing, engineering data on how to safeguard your insulation and the name of the Childers Engineering Representative near you. Write Childers Manufacturing Co., Dept. PP-9, P. O. Box 7467, Houston 8, Texas.

LAP SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of the jacketing, providing an automatic measure of the 2" circumferential lap. Proper lap is insured without waste. Labor is saved. Where desired, a positive weather seal is easily made with Lap Seal and a mastic.



FACTORY-ATTACHED MOISTURE BARRIER protects the underside of aluminum from possible attack by alkaline solutions present in most insulating materials. The moisture barrier, bonded at the factory by continuous strip adhesive, adds little to cost, saves application labor, insures against underneath corrosion.



TESTS PROVE EXTRA STRENGTH of rolled-in 3/16" cross corrugation. Vertical strength and rigidity of a .016" sheet with this 3/16" cross corrugation are increased to that of a plain .024" sheet. Jacketing costs are consequently reduced by as much as 1/3 when Childers Jacketing is used instead of ordinary sheet aluminum.

DEEP CORRUGATED Childers Jacketing in 1¼" and 2½" corrugations is recommended for permanent protection and improved appearance of insulated towers, vessels and tanks. Deep Corrugated Jacketing with factory-attached moisture barrier is another product available only from Childers.

Mill scale removal by Dowell started this new plant off with a $100,000 operating profit

Here's how the management of a multi-million dollar corporation used its knowledge of chemical cleaning to start a new plant off in the right way—in the black.

Following construction, and before the plant was put on stream, Dowell was called in to remove mill scale from the following systems:

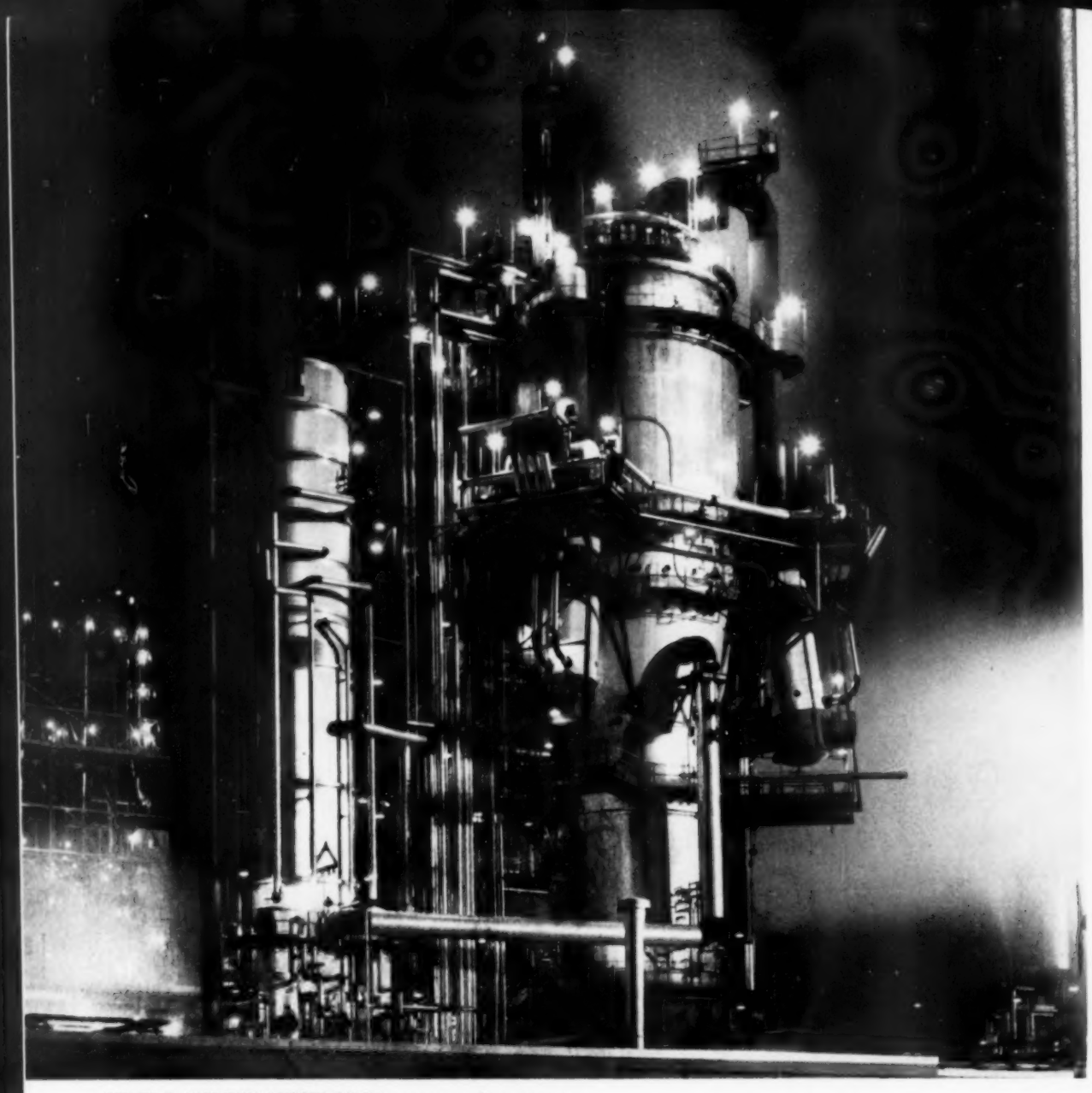
• Ammonia Compressors Suction and Discharge Piping • Engine Water-Cooling System • Engine Oil-Cooling System • Engine Jackets • Hydraulic Oil-Cooling System • Oxygen Suction and Discharge Piping • Miscellaneous Piping • Product Lines to Storage • Miscellaneous Towers

The total cost of this mill scaling was approximately $5,000. But, once in production, this plant did not have a single major shut down for maintenance caused by mill scale. The plant management credits Dowell Service with netting the plant an operating profit somewhere between 10 and 20 times the cost of the chemical cleaning. This amounted to between $50,000 and $100,000 the first year.

This particular case history is about a chemical company, but Dowell has startling performance data to show you—from your own industry. That's because chemical cleaning is so versatile. Dowell engineers are experts in removing scale and sludge from process systems, tanks and piping. They apply solvents in various ways—such as filling, jetting, cascading. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

have Dowell clean it chemically DOWELL



SINGLE COMBINATION UNIT processes all crude at . . .

Amoco's Latest— Built For High Yields

Spanking new Yorktown, Va. plant to yield 55-60% on crude

OPERATION and performance of the nation's newest refinery—American Oil Co.'s 35,000 b/d facility at Yorktown, Va.—will be watched with keen interest by the industry during coming months.

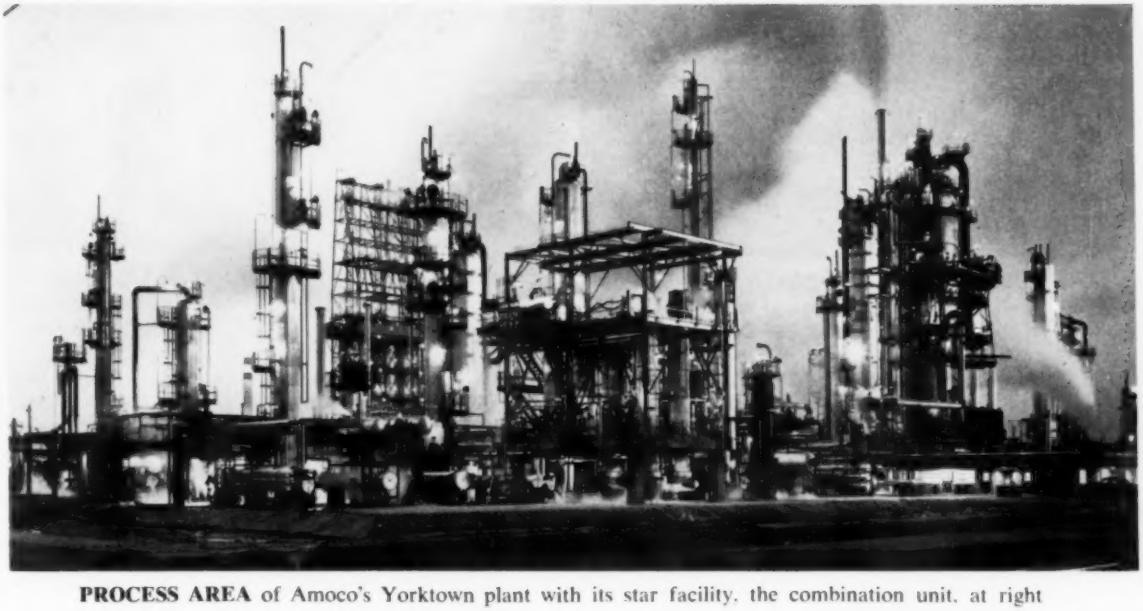
The first petroleum processing plant in Virginia has been going on stream since late in 1956, though it was dedicated formally just a few weeks ago (April 25). Essential details are shown in the accompanying table that appears on p. 219.

Aimed at high gasoline yield (55 to 60% on crude) with octane ratings that will meet the rising competitive market, the new refinery can claim a number of significant and interesting features.

Petroleum Processing
May, 1957

GAS RECOVERY SECTION gleams brightly in recent night view

BATCH-RUN COKING UNIT is designed to yield 600 t/d of coke



PROCESS AREA of Amoco's Yorktown plant with its star facility, the combination unit, at right

1—All crude oil will be processed through a single combination unit consisting of crude still, cat cracker, cat poly unit, and treating.

2—The catalytic reformer-hydrodesulfurizer will be operated at high severities.

3—Feed to the coking unit will have high carbon content (25%), producing 600 t/d of coke. A more typical feed in most refineries runs about 15%, produces 400 t/d in a unit of this size.

4—There is no unit for premium gasoline additive blending. Though not unusual with this company, this is unique practice in the industry. American's premium grade is an unleaded motor fuel.

5—Ratio of people in maintenance to those in operations is low—about 50 in maintenance to 140 in processing, based on hourly employes. This is a result of a contract maintenance arrangement.

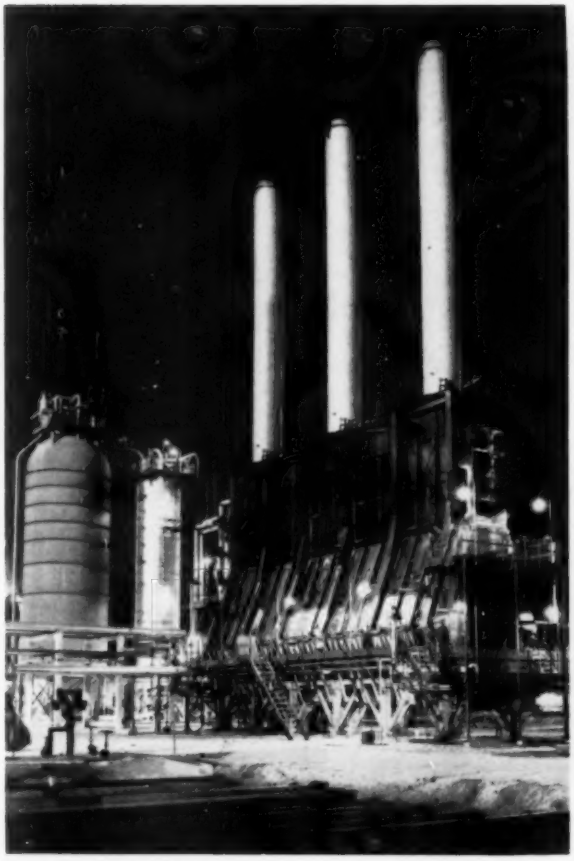
6—Instrumentation is electronic and electrical on the coker and on the reformer-desulfurizer, although the balance of the control equipment operates pneumatically.

A target for further new markets is evident in the plans American Oil announced even long before the dedication ceremonies—a 25,000 b/d asphalt plant and a 50 t/d sulfur recovery unit will be built at Yorktown. The latter unit will be constructed this year.

The combination unit, with four process steps, was constructed by M. W. Kellogg Co., which also had the contract for all auxiliary refinery facilities except tankage, docks and the administration building.

Chicago Bridge and Iron Co. built all the tankage, Tidewater Construction Co. the docks, and Virginia Engineering Co. the administration building.

An interesting feature of the combination unit is the inclusion of products treating, of which there are three types: copper chloride for the straight-run gasoline and kerosine; Petreco electric-treat for the heavy cat-cracked gasoline, and caustic sweetening on the light cat gasoline.



GIANT FURNACE processes 35,000 b/d of crude. Catalyst storage vessels are at left

COMBINATION UNIT consists of cat cracker, crude still, catalytic polymerization unit, and treating

The coking unit, charging 10,000 b/d of feed, is a four-drum, semi-continuous, delayed type unit. It was designed, engineered, and built by Lummus Co.

Coke produced in this unit—600 t/d—moves the shortest distance to market of any product. American Oil employs a 25-ton capacity earth mover to deliver coke to the new $49-million steam generation plant of Virginia Electric and Power Co., just a few hundred yards west of the coker.

The catalytic reformer-hydrodesulfurization unit, built by Ralph M. Parsons Co., uses the Ultraforming process developed by Standard Oil Co. (Indiana) with contributions by research and development men of American, a subsidiary of Indiana Standard. Reforming is to high severity. By-product hydrogen is used along with a cobalt-molybdenum catalyst in the desulfurization section to remove sulfur from reformer feedstock. The ultraformate produced is blended into American Oil Company's unblended premium gasoline, Amoco-gas.

Only 50 men comprise the total permanent maintenance force employed by the firm at Yorktown. This has been made possible by a contractual maintenance arrangement American Oil Co. has with Fluor Corp. The basic American Oil maintenance force is supplemented by another 50 Fluor men on a semi-permanent basis for all normal routing work. At peak load periods—for unit turnarounds and the like—Fluor will furnish additional men as needed.

Regular operating personnel for the refinery total about 140, averaging approximately 34 per shift (10 of these are on the combination unit). The balance of the 320 people at Yorktown are in engineering, supervisory, administrative, and research and development activities. Between 70 and 90 people were transferred to Yorktown from other American Oil and Standard Oil (Indiana) facilities; the remaining requirements were filled by hiring locally.

An interesting sidelight shows the task of finding new employes: American Oil had 5500 applications from local residents for the 250 jobs to be filled, an average of 22 people for every position.

The sequence of major projects and contracts involved in the Yorktown building program is shown in the accompanying text on facing page. It took 500,000 man-hours of work to plan and engineer the refinery. Then, it took another 4,500,000 man-hours to build it, with the construction crew hitting a peak of nearly 2,000 men. Five major construction projects were let and were completed on schedule.

The first tanker of crude oil was brought in to Yorktown in the summer of 1956. In December, 1956—16 months after ground was broken—the first gasoline ever produced in Virginia came from the combination unit. Other units went onstream thereafter.

With the completion of Yorktown, American Oil Co.'s total crude charge capacity in six refineries has reached 270,000 b/d. The company markets its products in 28 states from Maine to Florida to California, as well as the District of Columbia. It has progressed to this point from its beginnings in July, 1910, in Baltimore, Md., with three employes, and a 280-gal horse-drawn tank wagon, with its sole business the sale of kerosine.

Facts and Figures—American Oil Co., Yorktown, Va.

Capacity	35,000 b/d
Cost	$35-million
Location	On York River, three miles east of Yorktown
Acreage	1300
Products	Gasoline, kerosine, fuel oil, heavy fuel oil, liquefied petroleum gas, coke
Processes	Combination unit: 35,000-b/d crude distillation 30,000-b/d Orthoflow catalytic cracking 2,000-b/d catalytic polymerization Products treating 10,000-b/d coking unit, 600 t/d coke 6500-b/d Ultraformer—15,000-b/d hydrodesulfurizer Products blending
Future units	25,000-b/d asphalt unit 50-t/d sulfur recovery unit
Storage capacity	3,770,000 bbl
Dockage facilities	Pier extends 3000 ft into York River deep water, can accommodate simultaneously: a 700-ft supertanker, a 550-ft tanker, and two 250-ft barges. Twelve pipelines of varying size to handle crude and product. The 24-in. crude line can unload at the rate of 600,000 gal/hr
Loading rack	For tank truck and tank car shipments of gasoline, fuel oils, kerosine, LPG
Water usage	Fresh: 1.5-million gal/d, process and general Salt: 72-million gal/d, cooling
Total employes	325 to 350
Annual payroll	$1,750,000

Chronology—Yorktown, Va.—from historical to refining importance

1691—Yorktown established as a port town along south side of York River. Only 50 years before, the region was being settled by white men from the original British settlement at Jamestown, on the James River on the other side of the Virginia Peninsula.

1750—Yorktown reaches its peak as a thriving Colonial tobacco port.

1781—Lord Cornwallis and 7500 British troops arrive in the summer. But, by October 19, Cornwallis surrendered here at Yorktown to General George Washington.

For the next 150 years, business life settled down to farming, small merchants, and fishing.

1930's—The federal government established a Colonial National Historical Park in the region and established a number of military bases. The result was that over half of York County came under federal ownership.

1953—Sept. 25: American Oil Co. announced it would build a 35,000 b/d refinery on a 1300-acre site about three miles east of Yorktown, along the river, at an initial cost of approximately $35-million. It was the first petroleum refinery in Virginia and the first industrial plant in York County.

1953—Nov. 26: The Chesapeake and Ohio Railroad announced plans for a seven-mile track spur to provide freight service to the refinery.

1954—May 25: Wiley N. Jackson Co. of Roanoke, Va., awarded contract for preliminary clearing of 750 acres for the refinery site.

1954—Sept. 16: Tidewater Construction Co., of Norfolk, Va., was given contract for engineering, dredging, and construction of $1,750,000 worth of pier facilities.

1955—March 2: M. W. Kellogg Co. of New York, awarded contract for construction of combination unit, auxiliary facilities, and several refinery buildings.

1955—March 28: Chicago Bridge & Iron Co. awarded contract for building storage tank farm with total capacity of 3,770,000 bbl.

1955—April 5: Virginia Electric and Power Co. obtained 120 acres from American Oil to build a $46-million steam generating power plant adjacent to the refinery.

1955—May 6: Lummus Co., New York, received contract for engineering, design, and construction of 10,000 b/d coking unit.

1955—August 18: American's president, Donald J. Smith, "broke ground" for the first major process unit, the combination unit.

1955—October 28: Ralph M. Parsons Co., Los Angeles, awarded contract for construction of Ultraformer and hydrodesulfurization unit.

1956—February 26: Virginia Engineering Co., Newport News, given contract for construction of two-story office building and gate house.

1956—July 13: First consignment of crude oil is delivered to newly completed storage facilities by the S.S. San Juan, a T-2 tanker, tied up at newly completed pier. The San Juan delivered 125,000 bbl.

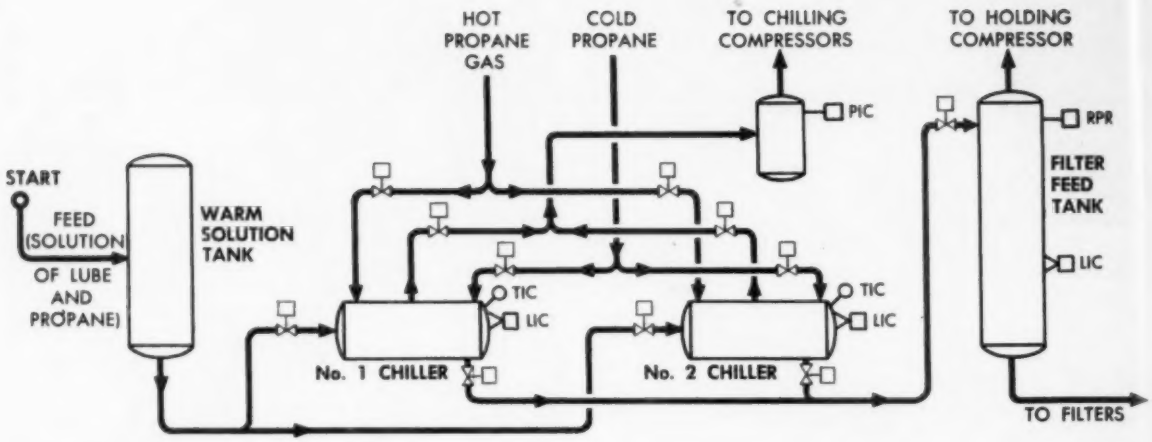
1956—December 18: Combination unit goes on stream.

1956—December 20: Office personnel move into new administration building.

1956—December 27: Operations begin at coking unit.

1957—April 15: Ultraformer-hydrodesulfurizer onstream.

1957—April 25: Formal dedication of refinery. Plans for further new units announced by American Oil—a 25,000 b/d asphalt plant and 50 t/d sulfur recovery plant, to be completed late in 1957.



How the operations work . . .

DEWAXING: A feedstock blend of propane and lube oil is fed from the solution tank at the left to the two chillers in sequence. The batches are chilled under automatic control by flashing the propane. Continuous rotary filters, fed from the filler tank at the right, separate the wax and oil.

CHILLING: The chilling drums are filled alternately from the warm solution tank. When a set level is reached, the propane is vented to the chilling compressors. Proper solution composition is maintained by adding cold propane. When the solution reaches a preset temperature, the chiller is pressured with propane gas and the cold solution is forced into the filter feed tank at the right. The two chillers are filled, chilled, discharged, warmed up, and refilled in sequence shown at right. The control panel board is shown at the far right →

Automatic Control Comes to the

How Esso controls chilling in a batch dewaxing unit

CONTINUOUS, fully automatic control of the batch-wise chilling operation of a propane dewaxing unit is now in operation at Esso Standard Oil Co.'s Baton Rouge, La., refinery. Developed by Esso's technical department, the system successfully extends the principles of automatic, continuous process control to this cyclic operation and has resulted in:

- Closer control of the chilling cycle
- Maximum filtering capacity
- More uniformity of product
- Increased unit throughput
- More efficient use of personnel

Biggest problem associated with automatic control of a batch, or cyclic, operation—which still plays an important role in the petroleum processing industry—is to find and maintain some reproducible factor in the process on which to base control of the operation. One simple method of extending automatic control to such processes is by use of a cycle timing controller, now used very successfully in home appliances such as the automatic clothes washer and the dishwasher. In these applications, the controlling factor is time.

The chilling cycle of the propane dewaxing process, however, is not sufficiently reproducible on a rate basis to yield optimum control with this technique. Esso's sequence control system provides flexibility to accommodate rate changes and still maintain automatic control.

The control mechanism uses a sequence principle based on the achievement of a predetermined value of a measurable process variable for each step in the process.

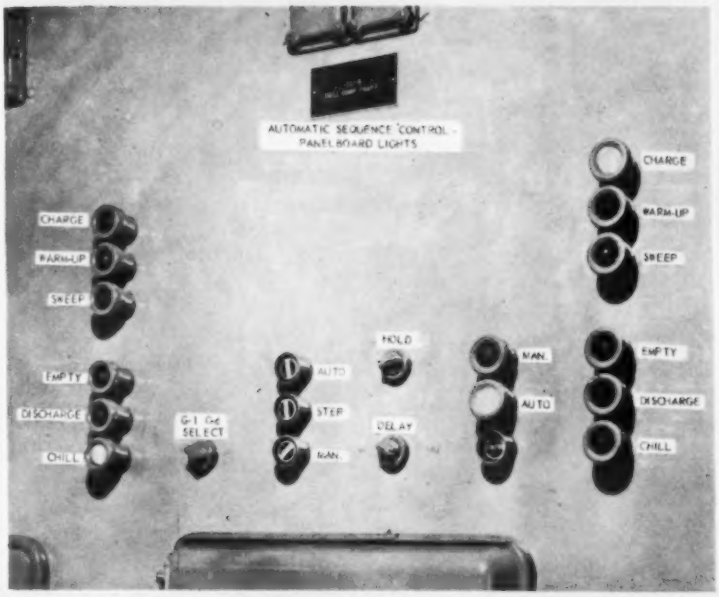
Here's how it works: the sequence chart above shows the ten steps required to complete one operating cycle. In sequence Step 1, chilling is started in the No. 1 drum. The rate of chilling is controlled by a rate-of-temperature-change controller that throttles the propane gas to the compressors. This portion of the rate of change controller uses a conventional cam to continuously reposition the control point at a predetermined rate. The chilling of No. 1 drum continues through sequence Step 5.

Also in Step 1, the No. 2 chiller is started discharging. The completion of the discharge step is indicated by a rapid rise in pressure in the filter feed tank. When the rate of pressure rise in this vessel reaches a pre-set value as detected by a specially designed rate-of-pressure-change instrument, the sequence controller moves to Step 2. In this position, the discharge valve is closed for approximately 20 seconds to allow the waxy stock remaining in the No. 2 chiller to flow to the discharge line.

After 20 seconds, the controller moves to Step 3, and the discharge valve is again opened until the rate of pressure rise instrument steps the sequence control to Step 4. During this step, the No. 2 chiller is warmed by introducing hot propane gas. When the chiller reaches a present temperature, the sequence control moves to Step No. 5, and recharging is started. When the chiller is charged to the pre-set level, the charge valve closes.

Sequence

Sequence steps	Number 1 chiller	Number 2 chiller
1	Chilling	Discharge
2	Chilling	Empty
3	Chilling	Sweep
4	Chilling	Warm up
5	Chilling	Charge
6	Discharge	Chilling
7	Empty	Chilling
8	Sweep	Chilling
9	Warm up	Chilling
10	Charge	Chilling



SIGNAL LIGHTS on control panel show sequence of automatically controlled chilling operation in propane dewaxing unit

Batch Process

By HARRY B. BREEDLOVE
Esso Standard Oil Co.

When the No. 1 chiller has been chilled to the pre-set temperature, the sequence control moves to Step 6, which is the counterpart of Step 1. The half cycle is repeated on opposite chillers, i.e., No. 2 chiller is chilled and the No. 1 chiller made ready for the next cycle.

Time required for a complete cycle is 40 to 60 minutes. This time is a variable and is dependent upon the feed stock being processed, the feed rate, chilling compressor capacity, and the final temperature required.

By the use of the sequence control system, the chilling of each batch is controlled as precisely as the preceding batch—making possible more uniform product quality. With some stocks, throughput can be slightly increased.

Two types of instruments of special design were required for this installation. All other equipment is standard off-the-shelf design. The rate of chilling controllers are conventional cam type temperature controllers; however, they are fitted with a special reversible cam drive to permit re-setting the cam automatically. An adjustable switch index is provided and is set to the minimum temperature desired for each batch. The warm-up index is set to maximum temperature desired before recharging.

The rate of pressure change recorder has two pens. One records the filter feed tank pressure. The second records the rate of pressure change in the filter feed tank. Attached to this second pen mechanism is a switch used to step the sequence control at the completion of Steps 1, 3, 6, and 8.

The photo shows the signal lights and control switches. The signal lights indicate the step being conducted at any time.

The sequence control board has levers that permit manual control of the process. An hermetically sealed six-level, ten-position, telephone type stepping switch is used to control the entire sequence.

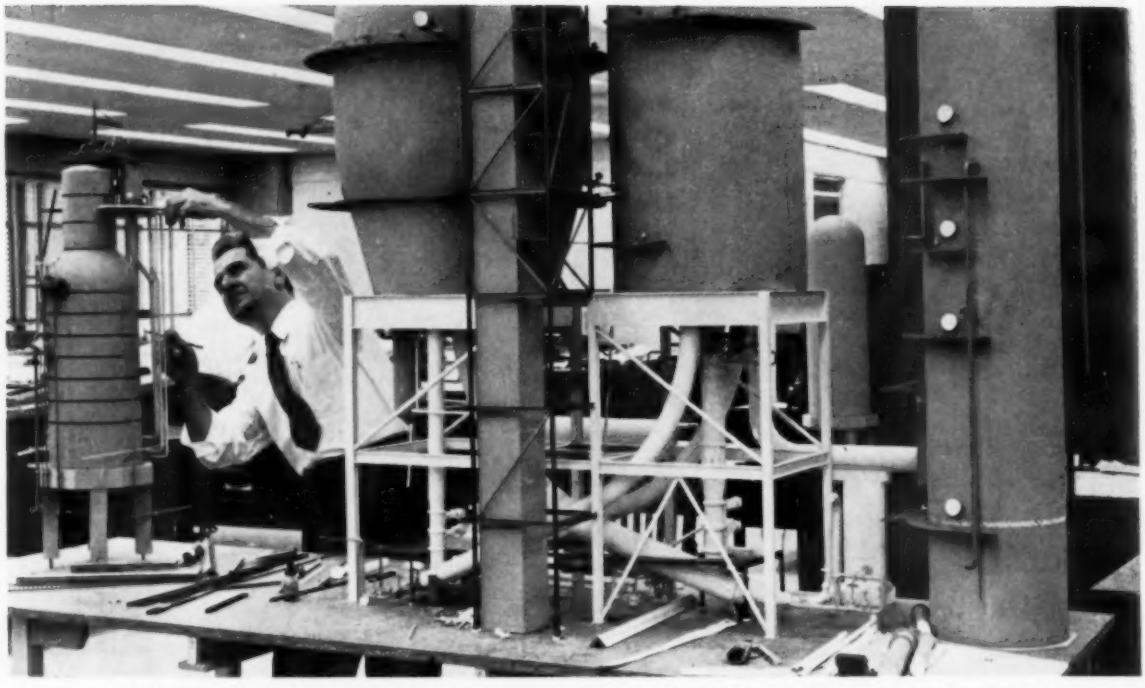
Start-up of the system was in November, 1954, and no difficulty was experienced during initial operation. A careful check-out of all components before the start-up and an extensive training program for the operators and maintenance people during the installation period is responsible for this initial success.

Service factor, or availability, for the control equipment has been about 98%, and failures have been minor. There have been four failures of component parts in the system since it was put in operation: one solenoid valve burned out, two pneumatic receiving bellows ruptured in the rate of pressure change instrument, and one pneumatic power cylinder failed.

Meet the author

Mr. Breedlove

Mr. Breedlove is an instrument application specialist in the Technical Division of the Esso Standard Oil Company's Baton Rouge refinery. He attended Louisiana State University, majoring in Electrical Engineering. During World War II he was Chief of the Automatic Flight Projects Branch of the Air Force at Wright-Patterson Air Force Base. He is married and has one daughter.



LARGE AND SMALL vessels for the design model are fabricated from the same plastic material

"Design Models Are Here to Stay" . . .

believes M. W. Kellogg, which has developed special techniques that permit use of the same model throughout entire plant design

By HAROLD KERSHAW, Special Development Engineer
The M. W. Kellogg Co., New York City

METHODS and materials unique to the model-making industry have been developed by the M. W. Kellogg Co. The purpose: to speed the construction of design models so they can be fully utilized in today's highly accelerated engineering schedules.

Kellogg, in company with industry at large, has used specialized models for many years. These have been made for research, development and testing of new equipment; for stress analysis of complex piping systems; and for exhibition or training purposes. Published articles have described methods of building models for design use, together with proposals of photographic techniques for scaled reproductions.

However, the concept of the scale model as a primary design tool for processing plant arrangement and piping is still relatively new. Over the past five years Kellogg had several such models built by specialists in the field, with varying satisfaction. It can be fairly stated that in no case were the more exaggerated claims realized. But, indications were clear that the scale model—if it could be built with sufficient speed to be properly used in conjunction with Kellogg's design practices—could be an effective aid.

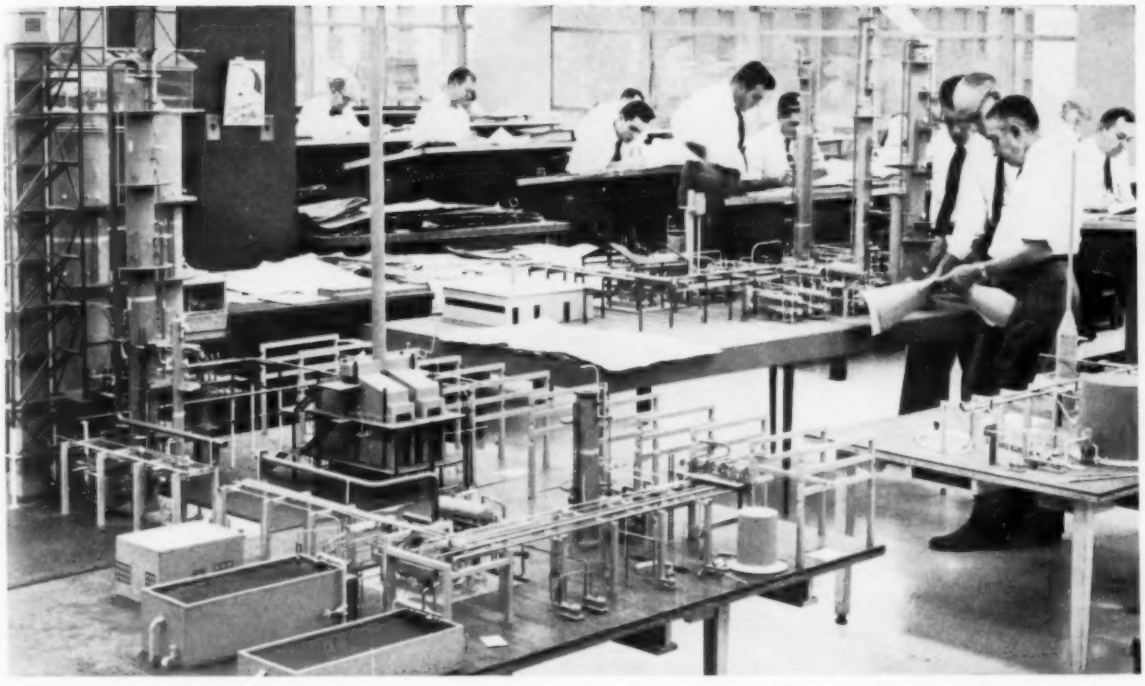
These trials with models influenced Kellogg to look further into possibilities for their design use. Becoming convinced of the soundness of the principle but dissatisfied with the ability of contemporary model construction to meet admittedly severe requirements, Kellogg undertook to develop its own model making facilities.

Our Cover

. . . this month shows the type of model that M. W. Kellogg now uses for designing large petroleum and chemical plants. In less than one year, Kellogg has completed design models valued at over $130,000, and are now planning to use this engineering tool as a regular part of their engineering-design-construction services. Author Kershaw is shown in the picture.

Developing a model program

The program was keyed to exploit the advantages of the Kellogg Planning-Production sequence of engineering design. This system provides a separately scheduled planning phase for each contract where the physical arrangement is defined, with limited detail and approvals obtained before



FOR EASY CONSULTATION by designers and draftsmen, the design model is assembled in the drafting room

proceeding with the production phase. Then, these limitations are expanded to produce detailed drawings for construction use.

Recognizing that rapid model construction was vital to the success of the venture, a useful degree of accuracy was selected and emphasis then directed toward high speed assembly and revision. Accordingly, a complete departure from existing model making methods and materials was made.

Experiments with newly developed plastics resulted in the selection of a single material that could be molded, extruded, expanded, shaped or machined, and which was available in several formulations to suit the different physical properties required of the various model parts.

Each model component was carefully designed to permit maximum preforming by commercial molding, and for assembly by simple means appropriate for use in the drafting room.

Difficulties with commercial manufacturing tolerances were solved, and a substantial investment was made in tooling and dies that would permit production in quality and quantity. Inventories of stocked parts were planned much as in other industrial operations.

An adequate shop was provided with machines developed or adapted for the rapid fabrication of items of individual design.

Equipment components are supplied by the model shop, which is isolated from the drafting areas. Pieces such as pumps, tubular exchangers, pressure vessels and other "standard" equipment are taken from preformed stock, and modifications are made as required. Compressors, furnaces and other "special" items are made from similar stocked materials.

Local assembly points are equipped with a catalogued supply of stock parts including miniature pipe and pipe fittings, which are secured to equipment and to each other by push fits. The piping is readily modified by reason of its simple assembly until the arrangement is approved. At this time it is made permanent by welding the joints with an injected solvent, allowing shipment without damage.

Structures are assembled either in the shop or at assembly points, depending upon model complexity and job progress.

Special clips, gudgeons, clamps and pins expedite assembly of such things as ladders, nozzles, structures, pipe supports, etc., and special jigs are used for cutting.

The resulting model has met every requirement for successful use in contract design engineering. In particular, the speed of assembly has proven adequate to meet the most demanding of schedules without sacrificing the realism of full scale components such as piping and structural shapes.

It has produced a "once through" result with no need for successive models. The one model is available for reference and use from the time it is started with the process release until plant operator training is completed. It proceeds apace with the design, reflecting at all times the current physical status of the work. It emerges at completion as a fully scaled, color coded miniature of the plant, available on the job site for use by field forces and the customer at the same time engineering drawings are issued for construction.

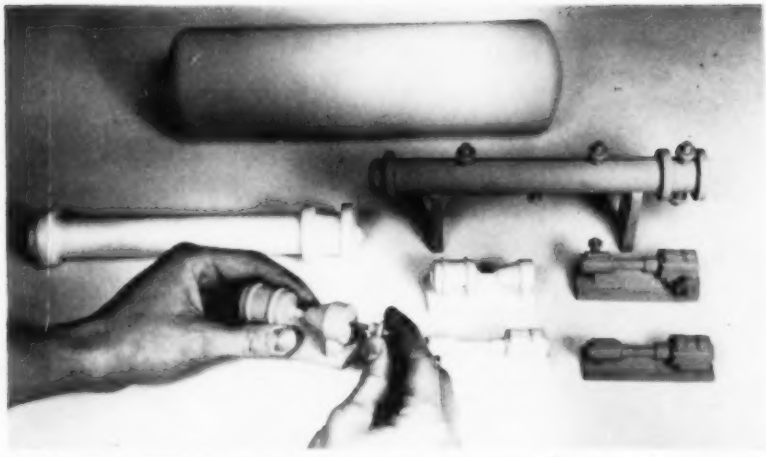
Reasons for design models

It is perhaps unfortunate that the conventional orthographic projection used in all drafting rooms is not well suited to complex subjects such as process plant arrangements, where special relationships must be mentally reconstructed at every use of the drawing. The techniques of isometric and perspective are used to help the interpretation, but they are limited in scope and employ drafting skills quite unrelated to actual design.

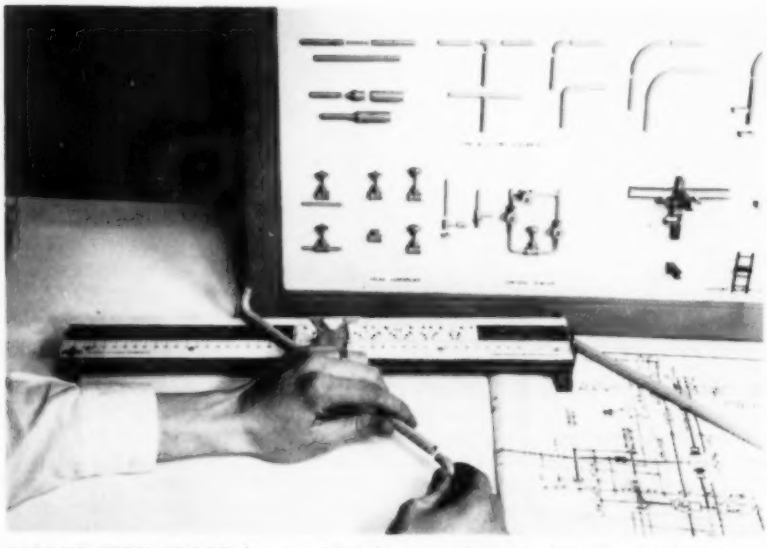
Simplified drafting practices using abbreviations, symbols and tabular standards with the elimination of "art" work, have been utilized in a continuing effort to cut engineering costs by reducing drawings to bare necessities.

(Continued on next page)

■ *Kellogg's model approach*



MOLDED NOZZLES are attached to pumps and vessels by hand. Hollow pipe is then slipped over the nozzle stub.



MODEL PIPE SPOOL is assembled from stock parts, just like field fabrication. Special jig measures straight lengths.

However, too often simplifications of this kind result in savings that are more apparent than real. Such drawings require practiced personnel to make and to read, and frequently result in a need for supplementary sketches for intelligent discussion and better understanding.

The competition for experienced engineers and designers is growing progressively more acute. The work load rests more and more upon seasoned employes who are now also required to spend a correspondingly greater portion of their time in training new people. Busy supervisors fight a losing race to keep abreast of current design drawings, a function necessary for quality and progress control. Departmental managers, who may not have a talent for specialized blue print reading, cannot be expected to assume this burden, even though they are often charged with direct responsibility for the finished product. In the processing industries, many members of the managements of both the operating company and the contractor are obliged to wait until the plant has been erected before the complete physical arrangement can be examined.

Layout models, properly constructed and scheduled, can serve both contractor and customer at all levels of responsibility by providing a continuous, easily understood progress report of the physical status of the job during all stages of design and erection.

Many articles have been published about scale models, pointing up the benefits of their use in plant design, construction, purchasing, operation and public relations. Some of these uses are obvious while others are revealed only after trial. Unquestionably the greatest advantages result from the unparalleled aid to visualization, which, of course, varies with the experience and the purpose of the viewer.

Requisites of a good model

The successful design model must satisfy two demands: speed and suitability to the design organization. The emphasis on speed, a characteristic of contract engineering, is the direct result of a competitive economy. The ability to complete a project in a shorter period than a competitor is frequently as influential in the awarding of a contract as a lower price. This situation in the process industries has produced highly efficient engineering organizations. Models, to be useful in design, must improve, or at least match, the rate at which a job progresses through the design departments.

Other types of design models tried to meet this requirement of speed. The most successful system employed a multiple model technique, which consisted of a design model using simplified equipment shapes and soldered wire for piping and simple structures. This was followed by supplementary models made from completed drawings to provide full scale realism for operator training and other customer uses.

Model kits, also advanced as an answer to speed demands, are not satisfactory for most processes. About 65% of the plant equipment can be carried in stock sizes, provided convenient means are available to make minor alterations. The remainder must be fabricated speedily and with reasonable resemblance to the actual equipment. Without this latter facility, "standard" pieces are valueless.

The benefits from use of a model are closely related to its accessibility. In an organization such as M. W. Kellogg, where plant layout is centralized, the model is assembled adjacent to the designer and under his immediate direction.

The accepted breakdown of a plant into design areas small enough for efficient handling is entirely suitable for model construction. It makes practical extending the design responsibility of the area to include the

model. It is ideal for instructing junior designers who assemble the model under the close supervision of the designer. It lends mobility to the model for transportation, and facilitates photographic reproduction. It reduces model time by allowing ready adjustment between groups of equipment in adjoining areas, a common occurrence in the course of developing a job.

Most importantly, however, design by areas with a model permits the designer the first opportunity to appraise his work as it goes into the model. It requires only the periodic assembly of individual model areas for overall plant coordination.

Getting the model accepted

The successful integration of models into the design organization is more than a matter of simple and quiet assembly. It requires the acceptance of a principle that challenges long-established customs. Its introduction is still sufficiently novel to arouse curiosity, even some resentment, among design personnel. Without the active cooperation of the designer in using the model, much of the benefit of the method can be lost.

The plant layout designer is not nearly as much a product of academic training as he is the result of long experience and a natural creative ability. He is very conscious of the fact that while the model shows with equal clarity the good and the poor points of his arrangement, few observers will comment on the good. The weak points, even if temporary, will be attacked with enthusiasm, even by those whom he has reason to believe are less qualified than himself.

Thus, it is most important that the model be recognized solely as a means of arriving at a physical arrangement, for it is a quick and clear means of communicating with others qualified in related subjects. But it must be firmly established that the model is subordinate to the design; that it is not an end in itself; that the company's product is the plant, not the model.

The M. W. Kellogg model has found wide acceptance at all levels within the company and by its customers, although it is to be expected that in some quarters such a departure from conventional methods has raised objections. However, as familiarity with the system increases, the acceptance of models for their demonstrated worth continues to grow.

Junior designers are quick to recognize their value as an incomparable means of instruction. The "feeling" for good design is developed by example, and facility in reading drawings is increased by the visual aid of the model.

The experienced designers are increasing their use of the model as a design tool as they see inferior arrangements become obvious and even acceptable arrangements made better and more economical.

When detailed design has been performed away from the main engineering offices, a design model placed in the branch offices has measurably improved liaison.

The customer benefits, too

Customer reaction has generally been gratifying. Models lend themselves admirably to group discussions and have noticeably facilitated agreement on controversial points. They often afford the only means by which the customer can be kept aware of the physical growth of the job during this critical period.

Often, a customer's staff is comprised of men whose skills have properly been developed along marketing, process, operational or maintenance lines, and who ordinarily have little need to become proficient at interpreting construction-type drawings. The real contributions that can be made by these people who must live with the plant are usually reserved until after it is erected. Comments made by them at this period receive a dubious welcome, because changes are expensive and delay plant startup. Thus, their experience is often wasted. By use of the design model, the customer can periodically review the plant in miniature. This review is accomplished quickly and with no chance of misinterpretation, saving the time of both customer and contractor.

Are models economic?

Very few people, if any, having contact with models will deny their use results in an improved design. The concern usually expressed is in terms of cost of making the model and, more specifically, the cost of engineering time spent in making changes and corrections as a result of viewing the model.

It has been charged that the model is an invitation to change, that it provokes the desire in all observers to do it differently. But it is significant that these same observers have not been able to comment upon the design drawings previously, solely because of their inability to decipher them, either through lack of time or talent. Obviously, concealment, even if inadvertent, at best postpones criticism until the actual layout is seen in the erected plant. But with a design model built concurrently with design, this should not happen.

Evidence gradually being accumulated by M. W. Kellogg and others in the same field indicates that there will be a change in the processing design industry. We can foresee a change from models that supplement engineering drawings to drawings that supplement an engineering model.

We at Kellogg are fully aware of the potential that lies in the wedding of photography and models. We are presently engaged in a full scale attack to advance this concept and are confident that this union will become a universally accepted part of engineering practice and tradition.

Meet the author

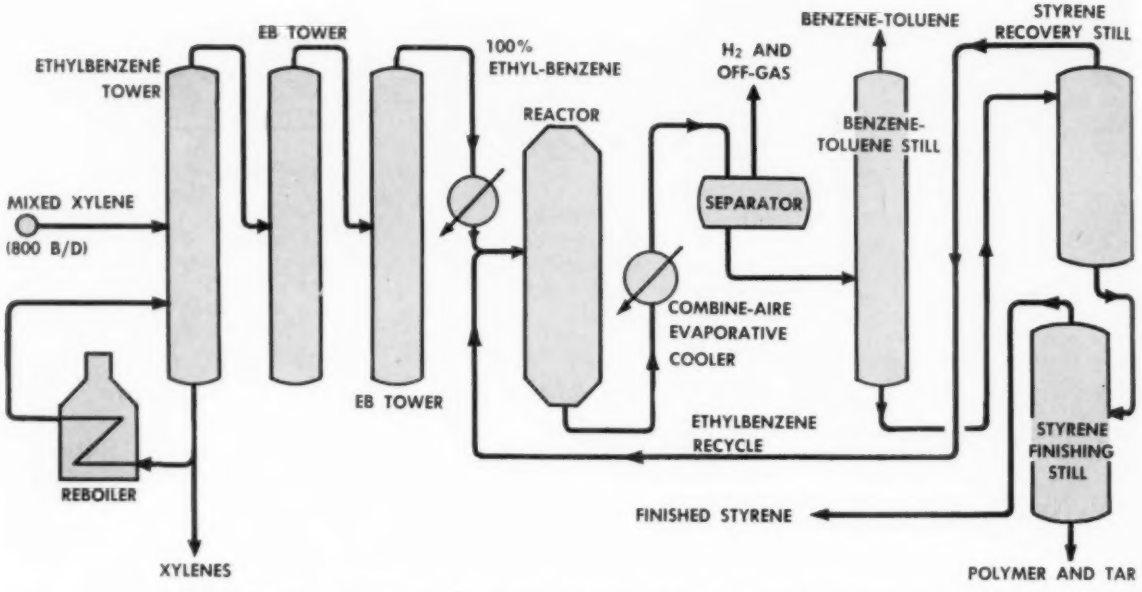
Mr. Kershaw

Harold Kershaw is well known for his discussions at ASME meetings on his favorite topic—plant layout. He began his layout experiences in 1927 while attending evening sessions at the Lowell Technological Institute.

After working in the design engineering department at American Locomotive Co. for nine years, he joined the M. W. Kellogg Co. as a piping designer and job leader in 1939. While at Kellogg he has developed an exchanger bundle ejector, and is co-holder of patents on Kellogg's plug valve for the Orthoflow fluid cat cracker.

In 1949, Harold organized the plant layout section at Kellogg and was section head of that group until recently. During that time he developed Kellogg's in-line plot layout, recently used in the design of American Oil Co.'s Yorktown refinery.

Mr. Kershaw has developed Kellogg's model program as a practical aid to design, and now holds the position as a development engineer for the further use of layout models in design and construction.



SIMPLIFIED flowchart of Cosden's method for direct fractional distillation of ethylbenzene from mixed xylenes shows novelty of technique

Cosden's Styrene Unit—They Said

COSDEN'S styrene plant—first of its kind anywhere—is in production and making the hypercritical separations that the experts said couldn't be made. The $3 million, 20 million lb/yr unit went on-stream in February of this year and has been in continuous production since that time, confirming Cosden's confidence in its revolutionary concept of "Ultrafractionation," and dispelling industry fears that the process was "impractical and commercially unsound."

While full details of the process are not yet available, it is evident that the unit has two commercial "firsts" of importance to refiners and petrochemical manufacturers everywhere:

- Direct fractional distillation of ethylbenzene from mixed xylenes, a separation of products having a boiling point difference of around 4°F.
- Separation of styrene from ethylbenzene in a single column, instead of the conventional two.

Ethylbenzene production

The entire refining and petrochemical industry has been awaiting the results of Cosden's attempt to separate ethylbenzene—basic raw material for styrene—directly from xylene. Neither

By RON CANNON
Southwestern Editor

Cosden nor Badger Manufacturing Co., designers and builders of the plant, are saying much now about how it is done, but the process apparently achieves the difficult separation by simple, straight-forward fractionation in three fractionation towers in series. Each tower is 200-ft high, among the tallest ever built, and the arrangement is such that separation takes place, in effect, in a single 600-ft column. The three towers contain a total of "over 300 trays—*not* bubble trays—of an improved design."

The most common method of obaining ethylbenzene in other commercial processes is by alkylation of ethylene and benzene with a suitable catalyst, usually aluminum chloride. Alkylation, as most refiners know, is a messy, costly operation, and accounts for a considerable percentage of the cost of producing styrene monomer.

Cosden, with a sizeable mixed xylene stream from its Platformer-Udex operation, conceived the idea of the direct route to ethylbenzene as a means of low-cost styrene production. While the separation is theoretically possible, it had never been done before on a commercial scale.

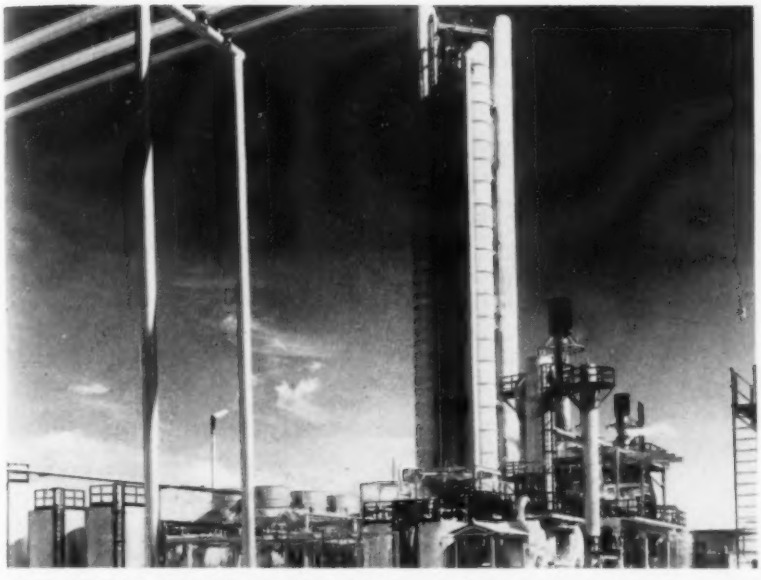
In this unit, the xylene, containing m-, p-, and o-xylene, along with a small percentage of ethylbenzene, is charged directly to the ethylbenzene columns, and a pure ethylbenzene stream is taken from the overhead for further dehydrogenation and purification into styrene. A direct-fired, multimillion Btu/hr reboiler heater at the base of the first column in the series supplies heat for the separation.

Dehydrogenation

Dehydrogenation of ethylbenzene to crude styrene is apparently a conventional process. Catalyst used is a commercial material (Shell 105 dehydrogenation catalyst) and the reaction takes place at 1200-1400°F. Heat of reaction is supplied by a single steam superheater. The reactor effluent is cooled in a large evaporative type cooler before going to the benzene-toluene still.

Styrene recovery

The styrene recovery step in this process is another departure from the conventional. Styrene has the disa-



ONE OF TALLEST FRACTIONATING TOWERS EVER BUILT leaps 200 ft over Cosden's novel styrene plant. Heater is at right background

THE 120-TON ethylbenzene towers were erected in one piece

It Couldn't Be Built

greeable tendency to polymerize at moderate temperatures, and losses can be excessive at temperatures above 90° C. Therefore, distillation of ethylbenzene from styrene is always carried out under vacuum. Even so, the pressure drop through the conventional still is such that the bottom pressure is too great to permit boiling the highly concentrated styrene at temperatures below the safe limits, and most other processes split the separation into two steps, with two separate stills.

Cosden's recovery step has a single still—under vacuum—but is apparently accomplishing the difficult separation without excessive polymer formations. Again, neither Cosden nor Badger has divulged any details, but they hint that the separation is possible because of techniques that allow greater separation per millimeter of pressure drop. This unit is believed to be the first to accomplish this separation in a single still.

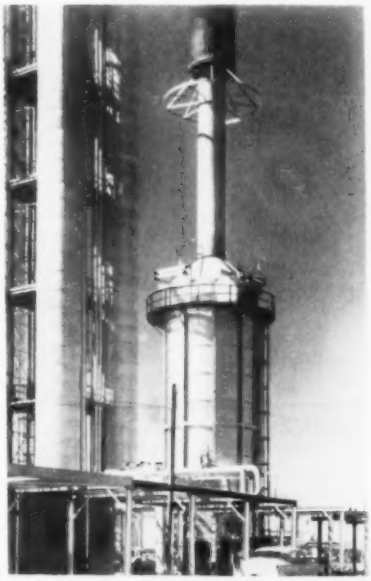
Styrene finishing

Final purification of the styrene monomer takes place in the finishing still, where styrene is separated from the impurities and small amounts of tars and polymers that collect through the process. In addition, a batch still —not normally in operation—is available to finish any off-test product that might get through the unit because of upsets in the process. This allows Cosden to clean up the bad product and still operate the unit at full capacity after correcting any operational difficulty. Present purity of the product is above specifications for plastic-grade styrene.

Construction began early in 1956, and was completed in about 13 months, despite the steel strike, which delayed construction for nearly two months.

Start-up of the plant was surprisingly smooth, and Cosden's vice president, Dan Krausse, attributes a large part of the credit for this success to the thorough training given operating personnel before start-up. "Within 24 hours after cutting hydrocarbons into the reactors," said Krausse, "the plant was producing 98.9% pure monomer. In a very short time, we were making rubber-grade styrene."

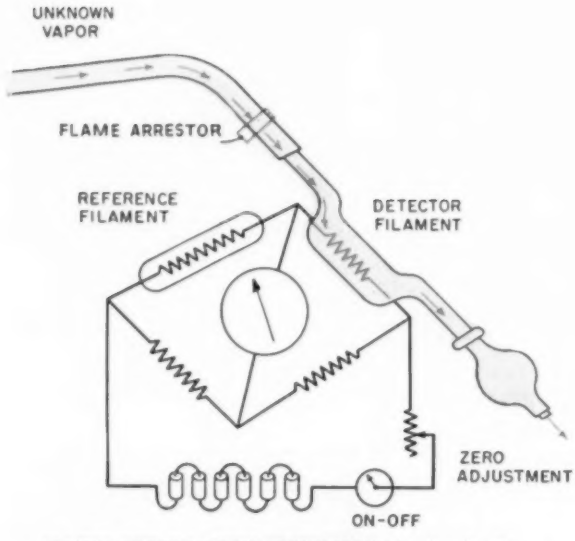
Indications are that the plant's initial production will be about evenly split between rubber and plastics outlets. Cosden has indicated that it will be able to meet its commitments "easily."



THIS ETHYLBENZENE heater has a multi-million Btu/hr capacity

COMPLETELY AUTOMATED unit is controlled from master control room

What Are the Limitations of



BASIC OPERATION PRINCIPLE is simple for combustible vapor indicators, BUT . . .

By WILLIS A. BUSSARD, Assistant Editor

TODAY several new hazards can affect the normal reliability of combustible gas indicators, or vapor testers.

The popularity of new but unspecified fuel additives, and the use of high-temperature silicone greases and new chemicals for processing petroleum and its products may be jeopardizing the reliability of these portable gas indicators. There are still people who do not as yet fully appreciate the dangers of using some of these instruments in the presence of desensitizing materials, such as tetraethyl lead.

Fortunately, however, if the operating limitations of this detecting instrument are clearly understood, safety personnel can continue to depend upon it for detecting explosive mixtures of combustible gases. But in the hands of an untrained and indifferent person, this detector can be a dangerous tool.

The common vapor tester in use today operates on the catalytic behavior of a heated platinum filament. As vapor is drawn over the filament, combustion occurs between the air and any combustible vapor that is present —even though the concentration of the vapor may be below the explosive limit. When this catalytic combustion occurs on or at the surface of the activated platinum filament, the electrical resistance of the filament is increased. By placing the filament in one leg of a standard Wheatstone bridge circuit, it is possible to measure not only the presence of a combustible vapor but its explosibility as well.

Other types of vapor testers have been used in the past since introduction of this instrument to refineries in 1927. The instrument described to the API by H. H. Hall in 1928 has been modified to meet new operating conditions and increase its flexibility.

Testers that operate on other principles are being tried out today (these are tabled on p. 231). However, none of these instruments that operate on other principles are as convenient or as portable as the platinum filament "sniffer" for checking explosive gas mixtures, and portability is often important.

But because platinum filament vapor testers operate correctly (and safely) only within certain limitations, they should be understood by anyone who uses, specifies or purchases them. Failure to recognize these limitations might well result in disastrous loss of both property and life.

How does it work?

The physical operation of a platinum filament vapor tester is difficult to explain because of the unsolved mysteries of activated platinum's role in catalyzing combustion. The fact that it does operate, though, is fully accepted. So an understanding of explosive mixtures and how they behave helps explain the limitations of present combustible vapor indicators.

Platinum, as it comes from the metal fabricator, is not catalytically active. It must be activated during the production of the tester. Several methods are used to do this, each manufacturer seeming to have his own secret method. Basically, however, the platinum is activated by operating the filament at abnormally high temperatures, either by excess voltage or exposing it to rich concentrations of combustibles. (One of the papers best describing these techniques is given in a recent French society publication.*) Because this procedure catalytically activates some parts of the platinum filament that will not be heated under normal testing conditions, it may lose some of this temporary sensitivity with use.

When an activated filament is used in a vapor tester, it is first heated with a specific voltage. But when the vapor-air mixture is burned by the catalytic behavior of the platinum, the filament temperature rises. This increased temperature further increases the catalytic sensitivity of the filament, especially if a highly explosive mixture is present.

Because the degree of catalytic activity is always reflected in the resulting meter reading, it is difficult to obtain successive absolute readings, or to compare the absolute values for two different meters.

Because of the difficulty of obtaining reusable absolute values, based on a changing activity of a very sensitive platinum filament, most vapor testers are calibrated to give safe meter readings. That is, they are calibrated on vapors such as hexane, heptane, or gasoline, so that

*Lyon Bulletin de Société Chimique de France, May 1956, pp. 808-813, "Investigation of the Catalytic Activity of Platinum Filaments," by Eyrand, Domanski and de Mourges.

Vapor Testers?

Combustible gas indicators are reliable and useful tools if properly used, but they WILL NOT:

- operate safely in atmospheres of acetylene or hydrogen, and pure oxygen.
- indicate toxicity of vapors.
- detect explosive mists (i.e., lubricating oil) or explosive dusts, i.e., coal dust.
- give true scale readings of L.E.L. for low vapor pressure materials such as carbon disulfide, butanol, xylene, etc.
- operate safely without flashback arrestors.
- operate correctly if liquid or condensed vapors are drawn into them.

any of the other gases tested will give an indication of a greater concentration than may be actually present. One way of avoiding this, of course, is to calibrate the tester for every possible vapor. But this nullifies the universal applicability of one instrument for testing explosive vapors, and also requires positive identification of the unknown combustible vapor.

Combustible indicators may be field calibrated by using one of the methods suggested by the manufacturers. One company supplies a field calibration unit that uses a cartridge of iso-butane, another has small ampules of styrene available, while another suggests a method using a small volume of hexane.

What are the operating limitations?

Although the procedure for operating a combustible vapor tester is simple, there are several limitations to its effective use. One of these is the operating temperature of the filament, which is quite difficult to control.

The importance of temperature in the use of any catalyst is well recognized in the petroleum industry. It is as important in the functioning of the catalytic platinum filament of a combustible indicator as in catalytic cracking or reforming operations. But unlike the latter procedures, close control of the temperature of a coiled filament is extremely difficult; the temperature varies over the entire length of the filament. It is hottest in the center but becomes progressively cooler as the supported ends are approached. The supporting wires at each end of the platinum filament conduct the heat away.

This temperature variation can be seen in any kind of coiled filament, whether in a lamp, electric heater or vapor tester. But in a combustible vapor indicator the variation is troublesome because the continued activation of the filament depends upon sufficient temperature to prevent desensitization by some materials (see table of desensitizing materials). But, if we attempt to keep the

How to read your combustible gas indicator

No combustible vapor-air mixture — arrow only fluctuates slightly on each aspiration

Below explosive limit —arrow rises only a small distance on the meter scale

At explosive limit— arrow rises to approach close to the lower explosive limit

Explosive mixture — arrow above L.E.L. shows mixture is violently explosive

Very rich mixture— arrow shows dangers; this mixture with air is violently explosive

What causes an explosion?

We speak of combustible vapors, not combustible liquids or solids, because nothing burns unless it is in a vapor or gaseous form. The tallow of a candle must vaporize before it burns. Similarly, the combustion of liquids found in refineries and petrochemical plants occurs only when the liquid has vaporized.

An explosion is a flash combustion in which the vapor combines rapidly with the oxygen present in the vapor-air mixture. But it will occur only under certain conditions (explained in EDS No. 15 on page 139, Mar'57 PP). The most critical of the required conditions is the right ratio of air-to-vapor, called the explosive range.

If the vapor particles are so widely separated that those set on fire will not ignite others that are near, the mixture is called too "lean," and will not burn. If the vapor particles are so close together that they exclude the oxygen (or air) necessary for combustion, the mixture is called too "rich," and it will not burn either. The percentages of flammable vapor-in-air that define this explosive range are labeled the lower explosive limit (L.E.L.) and the upper explosive limit (U.E.L.). Typical values are listed in the table opposite.

About the turn of the century it was discovered that an electrically heated platinum coil would produce catalytic combustion of gas in the presence of excess air. This meant that it was possible to bring about combustion even though the vapor mixture was below the explosive limit. It was this phenomenon that made today's combustible vapor indicators possible.

% Combustible in Air

For these Materials...	Explosive range is from ... L.E.L.	to U.E.L.
Octane—n	1.0	3.2
Benzine (ligroin, petroleum ether)	1.1	5.9
Xylene	1.0	6.0
Styrene	1.1	6.1
Toluene	1.3	6.8
Gasoline	1.4	7.6
Benzol (benzene)	1.4	7.1
Hexane—n	1.25	7.5
Pentane—n	1.4	7.8
Butane—n	1.9	8.5
Ethane	3.0	12.5
Acetone	2.6	12.8
Natural gas	4.8	17
Ethyl alcohol	3.28	19
Methyl alcohol	6.0	36.5
Hydrogen sulfide	4.3	45.5
Carbon monoxide	12.5	74.2
Hydrogen	4.0	75
Acetylene	2.55	81
Butyl alcohol	1.7	

Note: Explosive limits are expressed in % Vapor by volume in air. A more complete table is given on p. 139, Mar'57PP, in EDS No. 15.

filament at too high a temperature, we run the risk of vaporizing or melting the platinum. Even high temperatures somewhat below the melting point of platinum (2165°F) will greatly shorten filament life.

The best temperature for operation of combustible vapor indicators seems to be between 1100 and 1600°F, measured at the center of the filament. The higher limit is required to prevent desensitization of the platinum filament by vapors of TEL.

Some reactions do occur at lower filament temperatures, such as the catalyzation of hydrogen with oxygen by a clean platinum wire below 1000°F. But most other materials require higher filament temperatures for catalytic burning. Methane, for example, will react on a freshly activated platinum surface at 1400°F. But the surface will soon lose this ability even in ordinary atmospheres unless the temperature of the filament is held up around 1500°F. However, if strong desensitizing materials—tetraethyl lead, for instance—are present, the temperature must be kept around 1500-1600°F at the center of the filament to maintain sensitivity.

It has only been within the last five or six years that the need for maintaining high filament temperatures has been recognized by all manufacturers and users. Some of the earlier models of combustible vapor testers operated in the range of 1000 to 1200°F—and some models still do. As the table on the facing page shows, this temperature was adequate for many of the desensitizing materials likely to be encountered. But about 1950, the petroleum industry became aware of the effect of TEL on platinum filaments. Manufacturers boosted the voltage when it was realized that—unless the filament was constantly operated in the higher temperature range of 1400 to 1600°F—tetraethyl lead vapors could seriously impair the safety of vapor testers. These new models operate on eight, instead of six, flashlight cells and use the increased voltage to increase the filament temperature. This shift to a higher operating temperature has meant shorter filament and battery life on some vapor tester models but is necessary because of the increased presence of TEL vapors in refinery areas.

Is higher filament temperature the cure all?

There are three other important operating factors besides temperature that determine the reliability of combustible vapor testers:

- Use of desensitizing materials that will not react to temperature
- Retention of vapors by parts of the instrument, and
- Method of operating the vapor tester.

The facing table indicates that there are materials other than TEL that affect the safe operation of platinum filament vapor testers. Most can be overcome by high temperature, but one that is still puzzling the manufacturers and testing laboratories for a complete solution are silicones, especially those with a boiling point below 1000°F.

This new material is finding increasing use in refineries and petrochemical plants in special varnishes, waterproofing materials, high-temperature elastomers and special oils. Exactly how silicone products desensitize plat-

inum is unknown. One theory is that they decompose and deposit silica (fused sand) on the surface of a hot filament. This then prevents the platinum from reacting with any subsequent vapors passing over it.

Several methods have been tried for reactivating affected filaments, including soaking in hydrochloric acid and mechanical scraping of the filament. The most successful approach seems to be the exposure of the filament to a fluorocarbon, such as Freon. This, it is believed, forms volatile silicon fluoride (SiF_4) and frees the platinum from the poisoning material. But until a successful method has been fully developed for guaranteeing the operation of vapor testers in the presence of silicones, the only solution seems to be replacement of the affected filament with a new one.

Absorption of vapors by parts of the testing instrument itself is another danger that must be guarded against. For if this happens, a false low reading will be observed initially and a false calibration for fresh air on subsequent tests.

Most instruments are now made of non-absorbent materials throughout, although some in use may have absorbent sampling hoses. One government testing laboratory now specifies that fluorocarbon or epoxy resins be used for lining the sampling hose because tests have indicated that neoprene and polyvinyl alcohol hoses may absorb 10-15% of some types of combustible vapors. Natural rubber absorbs even more. One manufacturer states that the use of a natural rubber hose may decrease the sensitivity reading by 8% for each foot of hose!

The absorption of TEL vapors by the hose or some part of the instrument itself is not too critical if the temperature of the filament is constantly kept in the upper range. But, if the indicators are boosted only temporarily to the higher temperature to "burn off" the TEL effect from the platinum, there is the possibility that the latent effects of TEL may subsequently desensitize the filament. This is because residual TEL may lodge on monel flame arrestors, on plastic parts of the instrument, or on the sampling hose.

Why do vapor testers fail?

As can all instruments, combustible vapor indicators can fail and become inoperative. They can fail because of deactivation of the platinum filament, exhaustion of the flashlight cells, or a mechanical failure such as the plugging of filters or flashback arrestors.

Both of the platinum filaments—the reference and the test filaments—may give trouble. But it is usually the test filament that becomes inoperative. It is exposed to such a variety of stresses, while the reference filament is sealed in an air chamber. Three types of failure may affect the active filament: physical failure from melting, vaporization of the platinum metal, or loss of catalytic activity. The loss of catalytic sensitivity may be caused by the presence of dust, excessive usage, concentrated vapors of desensitizing materials like TEL, or exposure to silicone or other deadening materials.

Vapor testers must operate with a source of electrical power, which is usually a set of six or eight flashlight cells. These supply sufficient power for about 4 to 10 hours of continuous operation—or about 1000 tests on intermittent duty. But at some time proper initial adjustments can no longer be made. Then the batteries must be replaced.

The drawing of dirt or gummy substances through the vapor tester may be one type of mechanical failure. Others may result from rough treatment. But most failures of vapor testers are caused by deactivation of the catalytic platinum filament or weak batteries. The correct operation of combustible vapor indicators must take into account all of these possible causes of failure.

How types of combustible vapor indicators vary

Operating Principle	Manufacturer	Model No.	Safe for TEL?	Calibrated for:
Platinum Filament (catalytic combustion)	Davis Emergency Equipment Co.	Vapotester M-1, Type A	NO	Hexane
		Vapotester M-1, Type L	Yes	Heptane
	Johnson-Williams	J-W Sniffer Model F	Not for repeated exposure	Propane
		J-W Sniffer Model G	Yes	Propane
	Mine Safety Appliances Co.	Explosimeter 2	Only with an inhibitor filter	Heptane
		Explosimeter 5	Yes	Pentane
		Combustible Gas Indicators, Models 20, 21, 30 and 40	Must be adjusted at factory	specific gases
Color change of test solutions	Dragerwerk Lubeck (Germany)	Gas Detector Model 19/31	Yes	20 different gases
Optical comparison, index of refraction	Riken Fine Instrument Co. (Japan)	Methane Indicator	Yes	Methane only

Note: Calibration is checked by the vapors indicated. Sensitivity (of platinum filament) can be checked with methane.

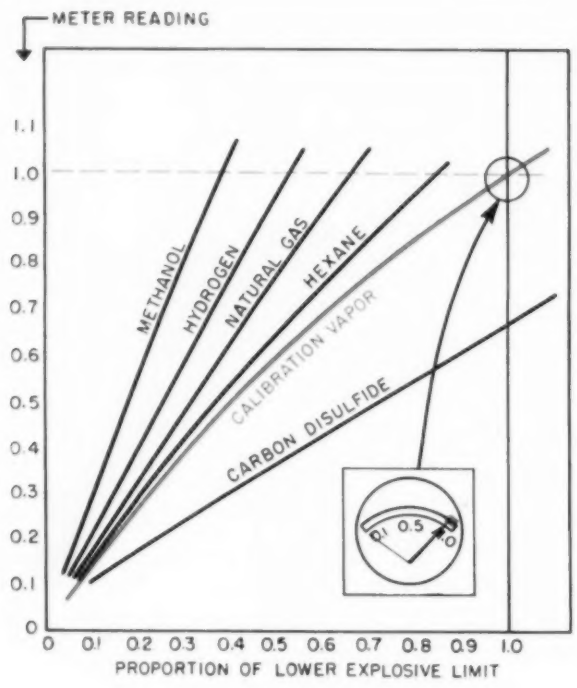
Misoperation is dangerous

As with other safety devices, failure to follow strict operating procedures with a combustible vapor tester can be the subject of an unwanted accident investigation.

Each manufacturer of this type of instrument puts out a complete booklet on the correct operation of his vapor tester. These instructions, of course, should be followed. Because all common vapor testers operate on the same principle (catalytic combustion), the main points of correct operation can be summarized, as on page 229. The important thing to remember is: *every movement of*

How platinum filaments are desensitized

Platinum filaments are desensitized by ...	Below temperature of ...
Arsine (AsH_3)	1300°F
Antimony hydride (SbH_3)	1200°F
Hydrogen sulfide (H_2S)	1020°F
Phosphides, reduced	?
Phosphates	?
Silicones	(at all temperatures)
Stibine	?
Tetraethyl lead	1500°F



Calibrating the indicator

The meter on a general-purpose indicator is normally calibrated with a test vapor that falls below the curve of many vapors likely to be encountered. Although this means that true quantitative readings are not applicable for most vapors—only for the test vapor—it is a built-in safety factor. Whenever an explosive reading is indicated it means that some *possible* vapor is explosive.

Notice in typical calibration curve above that vapors with low heats of combustion, such as carbon disulfide, will not give true readings. When such vapors are suspected treat them with extreme caution.

the arrow is important—not just its final resting position on the meter scale.

Selection of the wrong type of vapor tester can be dangerous. Some instruments are designed for methane and natural gas, some for specific atmospheres, while others are regarded as general purpose indicators. Most general purpose indicators are not designed to operate safely in atmospheres of pure oxygen, nor for testing high boiling hydrocarbons that have been vaporized in ovens.

It should also be remembered that a vapor tester gives two types of reading: (1) an operability or responsive reading, showing that some kind of combustible gas is present, and (2) a calibrated reading, indicating the percentage present of the lower explosive limit of one particular gas. Both readings should be heeded.

Sensitivity checks are simple

The continuing introduction of new chemicals as gasoline additives, fuel inhibitors, and processing aids is a potential danger. If any of them represent an undetected desensitizer to platinum catalytic activity, safety may be jeopardized.

But fortunately this possibility can be guarded against—by strict observation of simple checking procedures. Any user of a combustible gas indicator can, and should, satisfy himself beyond any possibility of doubt that the instrument is operating properly before he trusts his life or the lives of others to its indications.

Many follow a set procedure for testing each instrument before it is taken out of the shop. Using normal butyl alcohol, a few drops of gasoline on a cloth, or some other vapor similar to the expected combustible vapor, the meter is checked for workability before each use in the field. Many oil companies also follow strict procedures for periodic calibration of the indicators.

But in spite of these recommended checking procedures, there are still stories told of untrained personnel being entrusted with the operation of these important safety sentinels. One sworn-to story relates how some welders actually used a vapor tester *without batteries* to satisfy themselves that welding under certain conditions was permissible!

Play safe with vapor testers

Because there are many combustible vapor testers now being used in refineries and other industrial plants that *are* sensitive to existing chemicals, such as TEL, anyone concerned with using one of these instruments should satisfy himself on the following points:

1—Is the meter designed to operate safely in the presence of TEL? Or is it clearly marked NOT FOR USE WITH TEL VAPORS?

2—Has the man handling the vapor tester been instructed thoroughly in its operation? Does he know what each movement of the arrow means?

3—When was the instrument last calibrated? Is the date marked on it?

4—What combustible vapor was the meter calibrated against? How does this vapor compare with other vapors which are likely to be found in the plant?

5—Have any silicones been used in the area recently that might affect the operation of the indicator?

6—Does the presence of an Underwriter's or Factory Mutual label mean that the indicator is safe to use *under all conditions?* (Usually not!)

Before beginning any gas test with a combustible gas indicator, the user should check the zero setting with fresh air to make certain it is calibrated to give an accurate reading. If simple tests recommended by the manufacturers are made before a test for combustible gases is made, the user cannot be deceived into thinking that a dangerous atmosphere is safe.

Remember that the sense of smell is of absolutely no value in determining whether or not an atmosphere is explosive. Only a combustible gas indicator, operated correctly, will tell you that.

WHEELER

McGREGOR

LOGWINUK

MADDOCKS

THORNTON

HAIG

FORTER

HARDCASTLE

BOCHOW

JONES

HOUSER

PETROLEUM PROCESSING tape recorded the last regional meeting of the Western Petroleum Refiners Ass'n in El Dorado, Ark. Here is the fourth series of technical tips on processing problems from the complete transcript (checked for accuracy by each speaker). Moderator of the panel of authorities that answered all questions was Harry K. Wheeler of Pan-Am Southern Corp., El Dorado, Ark. Members of the panel were: D. W. McGregor, Lummus Co.; Dr. A. K. Logwinuk, Houdry Process Corp.; R. R. Haig, Esso Research and Engineering Co.; A. A. Forter, Cities Service Refining Corp.; C. A. Hardcastle, Lion Oil Co.; Carl E. Bochow, Suntide Refining Co.; Bruce Jones, McMurrey Refining Co.; Mark E. Houser, Republic Oil Refining Co.; R. R. Maddocks, Blaw-Knox Co.; and D. P. Thornton, Jr., Universal Oil Products Co.

This month's technical tips on . . .

Distillation, Thermal Cracking and Coking Problems

? Gas-oil distillation: What is the maximum superficial vapor velocity for vacuum towers used to produce gas oil for catalytic cracking charge? And, are your blankets being used above the flash zone in vacuum towers to reduce entrainment caused by the high velocity? If so, what experience has been encountered with plugging of the blanket with coke formation?

Mr. Maddocks

Maddocks: In answer to the question—what is the maximum superficial velocity for vacuum towers—from a process design standpoint, you must consider the type of tower—whether bubble cap trays or shower decks are being used, and, is it wet or a dry system? The general equation for calculating vapor velocities will apply in vacuum distillation. In designing a unit using bubble caps we consider the cross sectional area of the tower in determining the maximum superficial vapor velocity. However, in the use of shower decks, a vertical plane between two decks, located at the tray edge, usually represents a more important factor than the tower cross sectional area. In many vacuum towers utilizing "bubble-cap" type trays, we find a rate of about 50-60 bbl/sq ft of tower area. In other words, a 30,000 bbl vacuum unit would probably run somewhere around 25 ft in diameter. This usually holds whether it is a wet or a dry system because the factors of reduced volume compensate for each other . In general, you usually find that the tower diameter required for a tower using shower decks will probably be somewhere around 20 to 30% less than the tower diameter required for bubble cap design.

Going to the second part of the problem—the use of York blankets—I would like to bring your attention to an article printed within the last year in the *Oil & Gas Journal*, concerning Cosden's experience with York blankets. They originally had a York blanket in a vacuum tower immeditely above the flash zone and had a continual plugging problem that caused periodic shutdown and cleanup. Later they relocated the blanket two decks above the flash zone and used a gas-oil wash on the blanket. Such a change proved to be very successful in their particular case.

I've talked to other people having approximately the same conditions and there's quite a bit of controversy over the advantages of gas-oil wash. Before our session, one or two of the people expressed their opinion that the gas oil wash wasn't desirable. However, in Cosden's case it has been. Nevertheless, in designing a vacuum unit I would advise putting in gas-oil wash that could simply be discontinued if found undesirable.

? Coking heater steam injection: What are the effects of injection steam in coking unit furnace tubes on coke deposits? Does this aggravate foaming in the coke drum, also what can be done to reduce foaming and has anybody used anti-foaming agents?

Maddocks: In answer to the question concerning injection of steam into coking unit furnace tubes, I would like to refer back to one of Nelson's early refinery texts, which presented a plot correlating radiant rate and fluid velocity against coke deposits. This plot very nicely illustrates the desirability of having high fluid velocities and low radiant rates. Of course, the purpose of injecting steam is to obtain high fluid velocities during the high

temperatures period experienced in the outlet tubes of the coking furnaces.

I'm not sure that anyone can say definitely whether steam injection in the tubes has any effect on the foaming characteristics experienced in the coke drum. I rather doubt whether the two are associated closely enough to demonstrate this point. The Standard Oil Co. of Indiana has had some experience with the use of anti-foaming agents. At the moment I don't know anyone else who's using such agents. Most people have found that simply increasing the temperature in the coke drum itself has been sufficient to eliminate their foaming problems.

? Coking unit water injection: We understand from last year's meeting that some companies intended to try water injection on their thermal units. Did they do so and what were the results?

Maddocks: In last year's meeting it was indicated that D-X Sunray planned to use injection of boiler feedwater rather than steam injection in the coking heater for a new coking unit planned at Tulsa. As far as I know they went through with the plan. I can't answer how it worked out, however. Jack Eppard, can you tell us about that?

Eppard, (D-X Sunray): The coking unit at our West Tulsa refinery has used water injection into the coils in the coking heater to increase velocity in the tubes and thus reduce coking. This has been very successful and the only disadvantage is that it increases the pressure drop through the coil, and with present equipment limits the oil through-put.

Mr. Wheeler

Wheeler: One other point on York blankets brought up this morning—apparently there is a critical temperature. If the operating temperature exceeds it—the guess is something around 780 degrees—whether you've got a gas-oil wash or not, you're going to have trouble with coking. I think some panel members said that they put in a York blanket and it coked up. So they put in the gas-oil wash below it, and they cooled it off enough so it didn't coke up. then they took out the York blanket. Everything is still working just fine.

Forbes (Ohio Oil Co.): We've had very good success adding DC-200 into the top of our coke drums to reduce foam. Unfortunately our heater is limited at the current charge rate so that we cannot go to higher temperatures on the coke drum. We inject about 95 cc/min of a mix of 1/3 of our coker lean oil and 1/3 of DC-200. We have an Ohmart level indicator installation on our coke drums that has four radioactive sources with detection units at the 13 and 27 foot level in each drum. We actually plot when the foam passes these two levels, project the plot on up to the 7 ft outage level and inject the DC-200 when the foam reaches that point. We found that above that outage point we get considerable carryover of coke.

We tried injection into the top of our coke drum at one time, but at the top it was carried on over with the vapor. We found a connection 17 ft from the top that we could use, and we are injecting it at that point rigth now.

Mr. Forter

Forter: At the same meeting last year, our people were interested in the effects of water injection into a visbreaker coil. Unfortunately for us, we do all of our visbreaking or cracking in the coil and quench at the outlet of the coil—we have no soaking chamber. So we did try the water injection and increased the velocity in the tubes. But to offset and to maintain a conversion we had to go up in temperature. We now end up with about the same carbon laydown in the tubes under those conditions as we had before using water injection. So we answered our own question in that respect. Some of you may be thinking along the same lines and that's been our experience where you don't have a cracking chamber after the coil.

? Minimizing furnace tube coke: What about elimination of caustic to minimize coke from heater tubes?

Forbes: On our chemical desalter we were running a 9½ pH on the outlet because we thought we obtained a better separation at that pH. In our coker heater we found when we decoked in alternate layers that we were having a layer of coke and then a layer of white material. We ran an analysis on the tube deposit and found it contained a very high percentage of caustic. We immediately took pH on our desalter back down to 8.4 and since that time have been getting a 6-month run on our coker. At the time that we were getting this layer of caustic in our tubes. The caustic content of our vacuum column bottom was around 25 lb per 1,000 bbl, and it's down to 2 now. We feel we've remedied that problem.

Wheeler: Did it seem to accelerate coke production, or was it just there?

Forbes: I think that you will find that actually caustic does accelerate coke production and acts as a type of catalyst.

? Propane deasphalting: Has anyone considered or had any experience with two stage settling on propane deasphalting? If so, was a clean DAGO cut made on the first stage and the asphalt resettled or, was a poor DAGO cut made and the DAGO resettled? What were the results in improvement of yields and retention as compared to single stage operations?

Mr. Haig

Haig: Harry, I think you ought to point out that I got this question by default because no one else on the panel could answer it either. In the preparation of cat feed by propane deasphalting, I'd better first say that we used the tower type, we have obtained a comparable effect by cooling and returning part of the raffinate and solvent at the top to induce a temperature gradient on the tower. You can think of it in the same light as returning a reflux at the top of a regular fractionating tower. I don't have any numbers here on what the effects are but it has proven worth-

while to do that. One plant in the Jersey group has done it but unfortunately I'm not familiar with their operations.

? Distillation and sulfur compounds: What is the upper temperature limit that can be used in distillation without thermal decomposition of mercaptans and disulfides?

Maddocks: I believe I can give you some information on the first question. Mr. Kalichevsky, whom we all know, has done work on distillation of naphthas after doctor treating and in one of his discussions on the subject he points out that there are actually two important considerations. They are temperature, which is pointed out here, and also time. He suggests that distillation after treating be done under a vacuum, and points out that the temperature should not exceed 270°F, and preferably it should be held around 250°F. I think that answers the first question.

Downer (The Refining Engineer): I want to add something on the question raised about cracking of mercaptans and disulfides. Kalichevsky said 275° is the point at which you would get some regeneration.

At Esso's Baltimore refinery when they were Sodafining heavy catalytic naphtha, there was considerable trouble with the back end of that material. It was found necessary to rerun it and take a 400° end point instead of a 430° end point. They, at those conditions, did not get appreciable regeneration of mercaptans from the disulphides.

Dana (Atlantic Refining Company): On this point of disulfides breaking down to mercaptans. I think Mr. Kalichevsky is pretty correct except that you have to worry about the degree of disulfide breakdown. Certainly, if you're worrying simply about the doctor test, we don't have much trouble if we keep the temperature down under 300°. On the other hand, in the production of solvent naphthas, where you're worrying about an odor problem, we have had troubles as low as 250°. Odor problems in the production of solvents are becoming more and more critical, so we have to be pretty careful in that respect.

? Distillation of light hydrocarbons: At what temperature or under what conditions can the distillations of light hydrocarbons containing free sulfur be carried out and not produce a corrosive overhead product, after simple caustic wash?

Maddocks: I believe some of the people in the audience are probably more qualified to answer this question than I.

? Sulfur problems: During the distillation of light hydrocarbons, i. e., natural gasoline containing free sulfur, now does the free sulfur pass overhead? and . . .

Does anyone have data on the relative merits of using monoethanolamine and diethanolamine in the Girbotol operation to remove sulful compounds from light hydrocarbon streams?

Maddocks: The first is rather an academic question. However, I can give you some information on the other.

From data concerning the relative absorption characteristics of DEA, as compared to MEA, it is apparent that MEA has the ability to absorb about twice the amount of H_2S as DEA. However, one disadvantage of using MEA is its higher vapor pressure. In cases where you might be treating very high volumes of gas, the loss-of-solution problem arises and becomes more important in the event that you are using MEA rather than DEA.

Haig: It's been our experience that as long as the only sulfur compound present is H_2S, MEA is obviously better. But it's also more susceptible to forming stable compounds and complexes with other sulfur molecules such as carbonyl sulphide and some organic acids. The choice is always determined by economics. If you have nothing but H_2S in your gas, MEA is going to be cheaper. If you've got a mixture of sulfur compound, DEA may turn out cheaper in the long run.

Maddocks: One other thing. If you're scrubbing a gas such as flue gas, it's almost mandatory that you use MEA because it is the only amine solution that will resist oxidation.

? Removing thiocyanate salts: Has anyone devised a simple method of removing high concentrations of heat stable thiocyanate salts occuring in the Girbotol DEA streams?

Forter: We did add some soda ash, which forms soluable salts and that helped our unit. It's a very crude experiment. I wish I had some of our personnel who actually worked on it.

Maddocks: It would appear to me the way to separate this material would just be by re-distillation under vacuum.

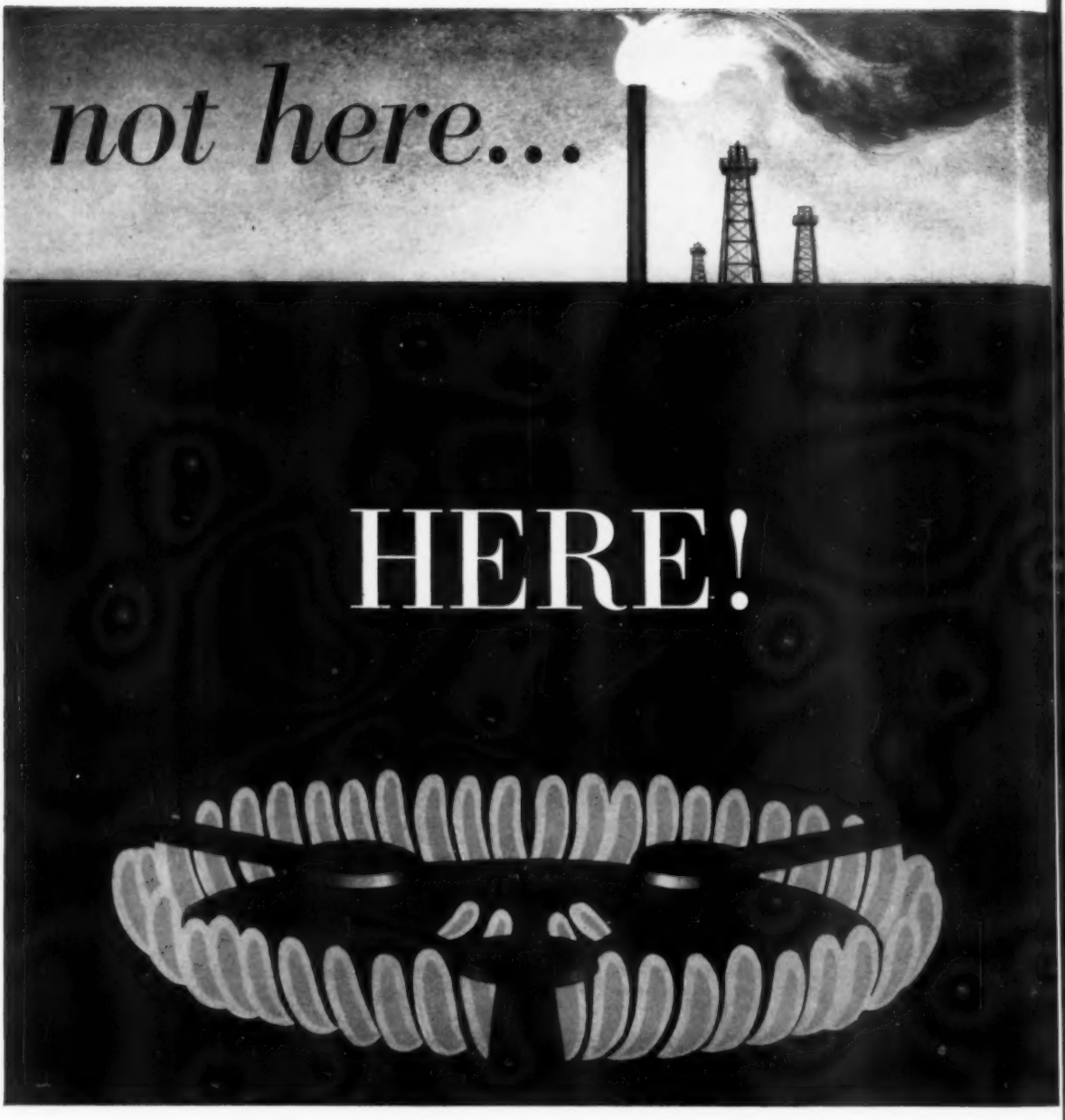
Wheeler: I think it was mentioned this morning that somebody goes around and does that. He's got a rig and his services are available, if you want them.

Eppard: The conventional method in gasoline plants that have large amine units is to regenerate the MEA solution in a separate vessel. A batch of MEA is drawn off to the regeneration vessel. Soda ash is then added and the MEA steam distilled.

? Range oil sweetening: Has anyone had any experience with the copper sweetening of range oil?

Haig: We haven't had any in the domestic circuit. Overseas, though we have. We found that on an extracted kerosine, copper sweetening works all right. It it's not extracted, you just can't make it work. I don's think that extraction is used very much in this country. Overseas, quite a few places are making an illuminating kerosine that has to be fairly highly treated. So the answer won't help anybody much—but for some reason or another, an extracted stock can be copper sweetened successfully.

Coming in June:
Questions and answers on REFORMING



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Your Guide to . . . Petroleum Processing

Departments

Keep Your Data File Up-to-Date

"Clip-n-File" process data

Process references—IV

Another coded, cross-referenced list of process literature. This month's data sheet covers specific subjects that appeared in PETROLEUM PROCESSING during 1954. **p. 241**

"Clip-n-File" engineering data

Instrument glossary

A continuation of last month's new compilation of terms, made expressly to clarify the changing instrument terminology situation. **p. 253**

Maintenance ingenuity pays off

A portable jig saves cat cracker shutdown time by letting Atlantic's Philadelphia maintenance men repair catalyst valve seats in place. This and other money savers appear in Plant Practices on **p. 245**

How to get steam with sand

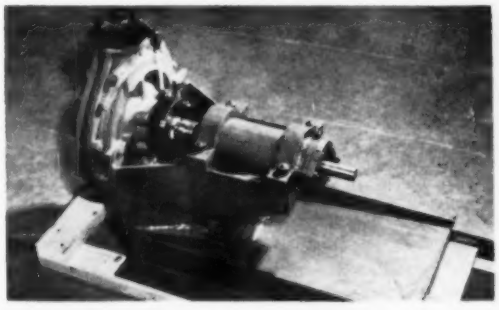
Another Bull Pen episode, and a particularly easy triumph for the Old Man. Hard Luck Sammy was suffering as usual, trying to make a boiler work, when the Old Man bailed him out. **p. 249**

Another coke problem solved

Can resid be cracked without excessive coke formation? Sun Oil thinks so in a patent on a 3-stream system, described with text and flow diagram in this month's Patents section. **p. 265**

Processing facts and figures

Do you check the Trends section regularly? Key industry statistics are tabled and graphed for quick reference each month on two fact-filled pages. To get the current refining picture turn to **p. 275**



Another corrosion foe is here

A Saran-lined pump is available, in two sizes, that permits a complete corrosion resistant system. Mechanical seals add to its efficiency. This and other new developments in equipment described in What's New, **p. 283**

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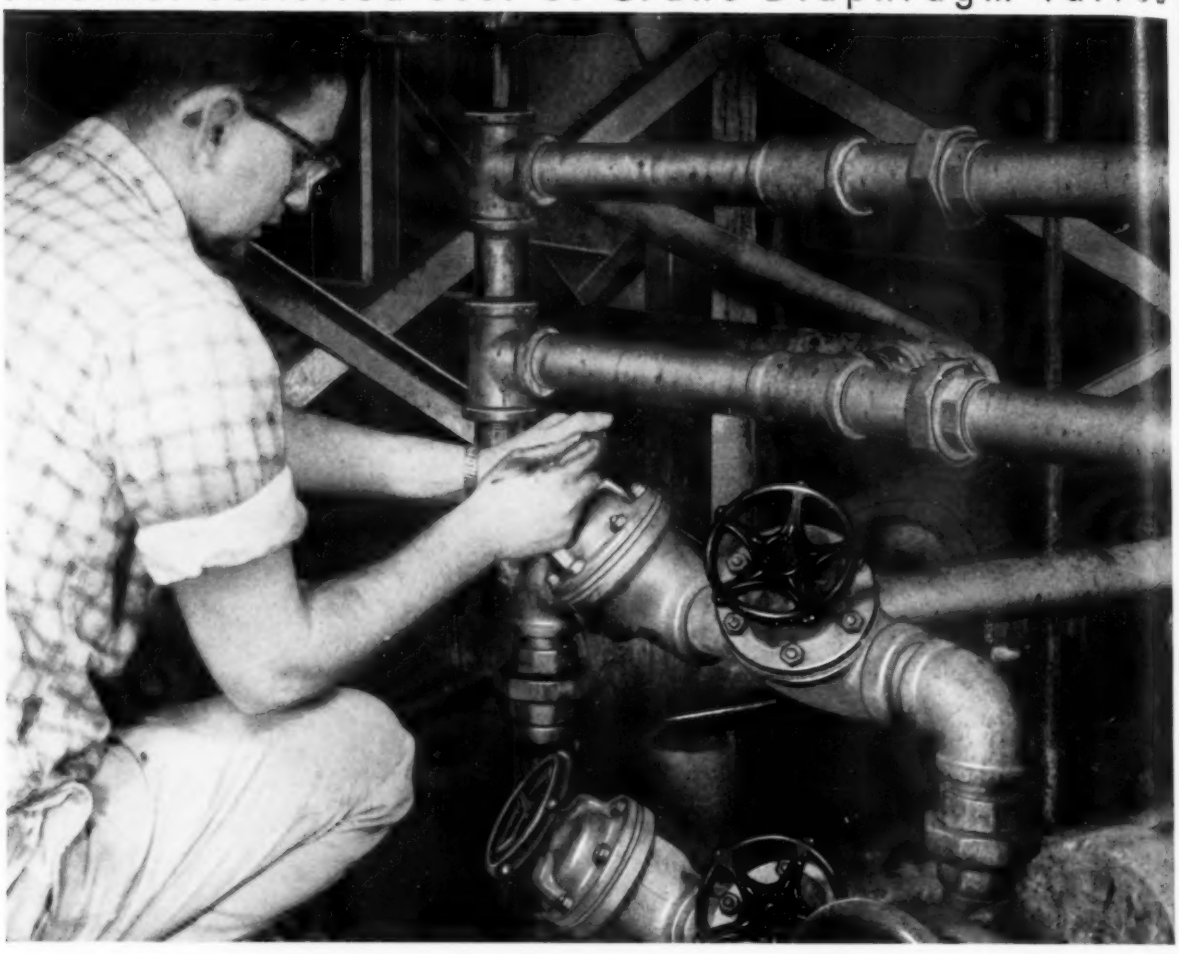
Another satisfied user of Crane Diaphragm valves



Best by test for this heavy, sticky emulsion —Crane diaphragm valves

What valve is best and lasts longest in this service? A West Coast emulsified asphalt producer tried them all on the manifold above and here's what was found.

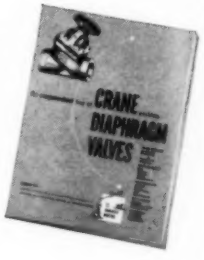
Conventional valves would become inoperative in a short time. The main trouble was binding of the stem in contact with the cold, heavy asphalt emulsion.

Ordinary diaphragm valves on the same service lasted only two months and had to be replaced. The diaphragms didn't stand up and the high torque required for closure was impractical for frequent operation.

Three years ago the plant started using Crane No. 1610 Packless Diaphragm Valves. The neoprene diaphragm functions only to seal the bonnet. It is not subject to crushing and excessive wear as a seating member. The separate disc in combination with Crane Y-pattern body makes positive closure with minimum torque and turns. These valves are giving full satisfaction.

Literature on Request

Wide choice of body and diaphragm materials makes these exclusive Crane valves particularly useful to process industries. Ask your Crane Representative for Circular AD-1942, or write to address below.



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Key letters after each article listed tell you the type of information to expect. **Cross-reference letter-number combinations** after each article listed tell what specific subjects are discussed in the article.

Article classification key

C = Chemistry or Formulae
D = Design Data and/or Methods
E = Economics, Costs and/or Markets
G = General or New Item
M = Materials and/or Equipment
O = Operating Conditions
P = Process or Plant Description
R = Reference to the Literature
S = Schematic Flow Diagram
T = Theoretical Discussion
U = Utilities for the Process
Y = Yields and/or Product Quality

Selected Process Article Listing—1954

F—Full-length feature articles

F1—"Man-Size Petrochemical Venture," V. B. Guthrie, Jan., pp. 83-85 **OPSY** (IV-9,26,52: V-46: VI-23,25,110,116)
F2—"Synthesis of Mesitylene from Acetone," Kenneth A. Kobe & Leo J. Hirth, Jan., pp. 92-93,96 **CORSTY** (IV-3,8,12, 13: V-2: VI-73)
F3—"Pernis—Rotterdam," V. S. Swaminathan, Feb., pp. 218-220 **GP** (I-4,5,27,38,42,49,51,61,62,70: IV-11: VI-17, 40, 43,67,58,96,104,106)
F4—"LPG Industry Continues Upswing," George R. Benz & Paul W. Tucker, Feb., pp. 222-223 **EG** (II-1,3,5,6,7,8: V-37, 44: VI-107)
F5—"The Economics of Making High Purity Aromatics," W. K. Jackson, C. K. Chadd, & D. M. Krausse, Feb., pp. 233-237 **EOPRUY** (IV-9,40,52: V-17,42: VI-23,25,110,116)
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F7—"Cracking Unit a Source of Heat?" O. F. Campbell & N. W. Pennels, Mar., pp. 352-358 **DMOPSU** (I-4,10,27)
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85—Parathion (F39)
86—Pesticides (F39)
87—Phenol (F6,22,25,35)
88—Phenol-Formaldehyde (F31)
89—Phenol-Furfural (F31)
90—Phthalic Anhydride (F27,31,35)
91—Plasticizers (F31,35)
92—Polyesters (F31)
93—Polyethylene (F31,35: T1)
94—Polyglycols (F35,38)
95—Polystyrene (F31,35)
96—Polyvinyl Chloride (F3,35)
97—Propylene (F17,22,35: T6)
98—Propylene Tetramer (F30,35)
99—Resins (F31,35: T7)
100—Resorcinol-Formaldehyde (F31)
101—Saran (F8)
102—Styrenes (F22,25,29,31,35)
103—Sulfonates (F30,35)
104—Sulfur (F3,22,32,35)
105—Sulfuric Acid (F35,37)
106—Synthetic Detergents (F3,30,35)
107—Synthetic Rubber (F4,29,35: T6)
108—Teflon (F31)
109—Tetraethyl Pyrophosphate (F35,39)
110—Toluene (F1,5,20,22,26,28,35)
111—Trichloroethylene (F14,35: T2)
112—Urea (F22,33,35)
113—Vinyl Chloride (F14,22,28,35: T2)
114—Vinyl Resins (F31,35)
115—Vinylidine Chloride (F31,35)
116—Xylenes (F1,5,20,22,28,35)

H. R. (RUSS) ARNOLD (right), Plant Engineer, Riegel Paper Co., Acme, N. C. Left, Clayton Heintz, Cooper Alloy Corp.

ARNOLD OF RIEGEL PAPER

tells why he specifies COOPER ALLOY stainless steel valves

Q. Mr. Arnold, why do you buy Cooper Alloy valves?

A. Cooper Alloy's 35 years' experience in casting stainless steel exclusively, particularly qualifies them to handle our corrosion problems. With a toothache, we go to a dentist—so here too a specialist is required. This know-how shows up in design features which I find in combination nowhere else, assuring reliable performance and lowest maintenance. Some of the 10" OS&Y gate valves in the photo have been in service for years without repair.

Q. *What are some of the design features you refer to?*

A. The extra-deep stuffing box with unique square compression along with two-piece gland and centerless ground stem gives longer packing life. The yoke nut, replaceable without valve disassembly, and bowed yoke designed to relieve stress on operating threads in radical temperature change services, make for less maintenance and longer life.

Q. Are there any other reasons for buying Cooper Alloy?

A. Yes. In addition to good deliveries, I find the engineering counsel you give us most helpful. Also important in Cooper Alloy, we have a single source for valves and the wide variety of flanged, screwed, and welding fittings we require in stainless steel.

A VALVE *DESIGNED* FOR STAINLESS! The Cooper Alloy valve is not an adaptation of earlier brass or iron patterns. Cooper Alloy, with over 35 years of experience in handling stainless steel, created a valve *designed to be cast* in stainless. To get the details, write today for your copy of our free 12-page folder "Valve Technical Data."

The Cooper Alloy distributor near you will be glad to show you the complete line of Cooper Alloy valves and fittings, and can serve you promptly from local stocks.

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says SOCONY MOBIL

Why does Socony Mobil use **dbpc** antioxidant, made by Koppers, in both its regular and premium grades of gasoline? Because **dbpc** gives excellent protection against gum formation in gasolines, yet is easily and safely handled, does not induce tank sweetening, is insoluble in aqueous alkali and is low in cost. The combination of good inhibition and *lack* of detrimental characteristics is helping Socony Mobil achieve good stability at low cost.

dbpc is effective in aviation fuels and anti-knock fluids, too . . . and helps prevent sludge formation in insulating oils and industrial oils.

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In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

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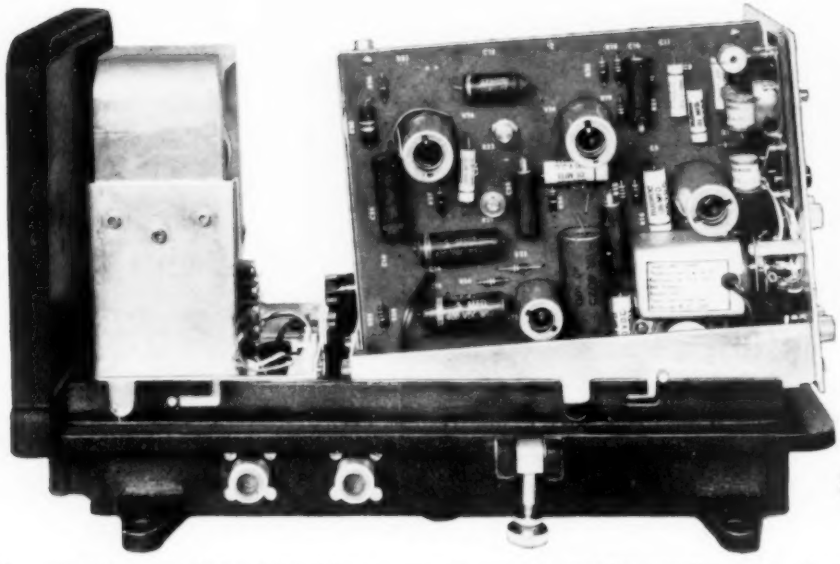

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1. The unit is continuously standardized automatically. It assures complete electronic balance and permits optimum response adjustments. There are no slide wires, no batteries, no moving parts.

2. Easy continuous adjustment of range span and zero suppression—exclusive Taylor vernier adjustment gives exceptionally fine accuracy in calibration of the unit. You can completely change the range and zero suppression as plant conditions demand—only need one instrument as a spare.

3. Quick, simple removal for service with minimum instrument down-time . . . means that checking can be done efficiently in the shop where full facilities are available.

4. Modern printed circuits insure uniform performance because there's no variation between units. Principal electrical components are identified by engraved numbers on the phenolic board—another simplification for the maintenance technician.

5. Quickly adapted for use for different primary elements because you just plug in the corresponding service "can". "Most ingenious . . . and most practical"—that's what instrument men say about this important addition to the TRANSET* System.

That this ingenious instrument works so well in so many places is another reflection of the years of experience of Taylor instrument engineers in helping solve the problems of the processing industries.

Your Taylor Field Engineer can suggest where a Taylor Potentiometer Transmitter will help you in your processing picture. Write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

*Reg. U.S. Pat. Off.

Taylor Instruments

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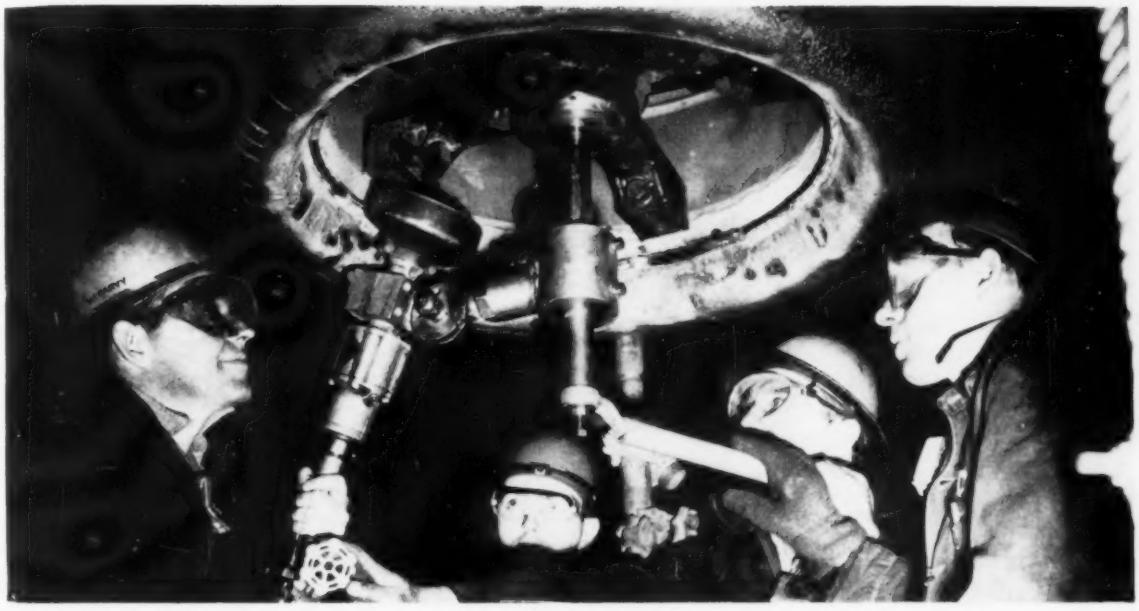
ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY

(To obtain more data on advertised products see page 280)



This special jig permits . . .

In-place repair of valve seat

WHEN the fluid cat cracking unit at Atlantic Refining Co.'s Philadelphia refinery was inspected at turnaround, the seat of the 38-in. plug valve was found eroded by catalyst. It was serious enough to require a welded repair and the problem was how to do it without removing the plug valve to the shops.

Normal repair procedure was to overlay the damaged area with weld metal, then grind the valve seat to specifications. Although the field welding was not a problem, the alignment for grinding the valve in place was. But the mechanical department came up with the solution: the special jig, shown above.

The jig is made of a bearing housing, the bearing and a vertical shaft assembly. These main components are secured in position and aligned by four jack bolts, each at the end of a horizontal arm. The pneumatic grinding machine is attached to the shaft through a swivel clamp that provides horizontal, vertical and rotational alignment.

Manual rotation of the shaft revolves the grinder into whatever position is established by adjustments in the clamp. And the rigid assembly and versatile swivel assembly permit grinding the valve seat to any specified limits.

Using this special jig, Atlantic maintenance group can now economically repair plug valve seats without taking the valve to the shop.

Video checks refinery employes

CLOSED-circuit TV has taken over the job of monitoring one of the plant entrances for employes at Esso Standard Oil Co.'s refinery

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end
to
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measure
of
quality,
service
and
dependability
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in Baton Rouge, La. To the left is what a guard on duty sees on the screens of two separate TV receivers.

On reaching remote-controlled turnstile at the entrance, the employe presses a buzzer to attract the guard's attention. Then, a small TV camera picks up a closeup of the badge worn while a larger camera, mounted above the fence, flashes a picture of the employe and the surrounding area.

After matching the employe's picture with that on the badge, the guard opens the gate by pressing a release button. A green light flashes at the gate to indicate that the turnstile will revolve.

The turnstile is controlled to turn only long enough for one person to enter. Because the larger camera covers enough of the area surrounding the gate, the guard can make sure that no unauthorized person tries to enter at the same time. Instructions for operating the video monitor are mounted at the gate.

Have trouble switching boxcars?

IF YOU have an acute railway-car handling problem that cannot be solved by a regular switching engine because of its size, you might note how Wyandotte Chemicals Corp. solved a similar problem.

At its petrochemical plant located in Wyandotte, Mich., Wyandotte Chemicals did not have enough room in some areas to use a regular switching engine. Space was just not available, particularly around the dry ice plant, where there was a special need for positioning cars tightly to the plant doors for loading and quick closing. Otherwise, there would be excessive sublimation of CO_2.

To solve both problems, an old motor truck chassis was adapted to rails. A 1941, 85-hp Ford V-8 with a 1946 body was mounted on a lorry. It, in turn, was mounted on railroad wheels. Power is obtained through a general drive from a regular transmission to the lorry wheels.

This converted unit has been in successful operation at the Wyandotte plant for about 15 years and is capable of adequately pulling four loaded boxcars.

Check list for gas-freeing tanks

GAS-FREEING of storage tank atmospheres with a steam eductor at the outlet and fog nozzles at the inlet is a relatively new procedure. But it has already been adopted as a safer way by Shell Oil Co. at its Norco, La., refinery.

The procedure is relatively simple

and consists of the following setup. Air is drawn through a curtain of water fog at the top of the tank, and is pulled from the bottom of the tank by an eductor mounted on another top opening. A flexible, collapsible tube reaches from the eductor to within a foot of the bottom of the tank and sucks out the heavy vapors that settle to the bottom.

Although this method usually results in freeing tank atmospheres within one hour of explosive vapors, there are several important points in the procedure that should be observed. The following is a check list of these points:

1—Before removing the tank from service, haul all needed equipment to the tank site. Flexible hose for all utilities is preferred.

2—Pump out all possible product through existing lines. Float the remainder with water and pump out.

3—Blind all piping connected to the tank, except the drain and foamite lines. Wash all disconnected piping and then blind all shell nozzles and manways.

4—Use two eductors and four fog nozzles on all tanks of 55,000 bbl and larger. For smaller tanks use one or two eductors and two fog nozzles.

5—Place fog nozzles between eductors and in the largest openings in the tank roof. Be sure the fog nozzles are grounded and adjusted so that the water spray covers the entire opening.

6—Turn on the water to the nozzles.

7—Attach eductor to the roof manhole and lower the flexible tube to within a foot of tank bottom or liquid surface.

8—Open the steam or air to the eductor slowly. Take five minutes to open the supply valve wide to prevent sudden vacuum within tank.

9—Evacuate all employes from the working area for at least one hour, or until a work permit is obtained from the safety dept.

10—Continue ventilating tank until gas tests show less than 50% of the lower explosive limit. Only then open shell nozzles and manways for cleaning.

11—Shut off fog nozzles but continue ventilating throughout the entire cleaning and repair period with the eductor.

12—The roof of a black or unpainted tank should be cooled approximately 15 minutes before and during gas-freeing with a water spray or sprinkler.

13—Return tank to service in customary way.

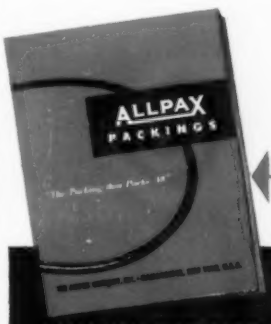
I'm an all-around "PETROLEUM PACKER"

Petroleum service separates the men from the boys in the packing field—but you can count on Allpax Packings for this rugged service. They're the result of extensive laboratory research in the development of suitable packings for service against distillates and petroleum products. Recommended for use on centrifugal and rotary pumps, valve stems, swing joints and similar pumping equipment.

Style No. 14 – For regular petroleum service. Excellent against gasoline, light and heavy oils, benzol, toluol, etc. For temperatures up to 550 degrees F. Compounded of long asbestos fibres, fine flakes of graphite, and a special bonding compound containing an oil-resistant lubricant.

Style No. 13 – For extremes in high and low temperatures.

Style No. 30 – For use against petroleum products at high temperatures and pressures. A very dense packing, made by braiding jackets of asbestos yarn over a center core of pure asbestos content. The jacket is treated with a special heat-resistant compound. The outer jacket is lubricated with a coating of graphite.



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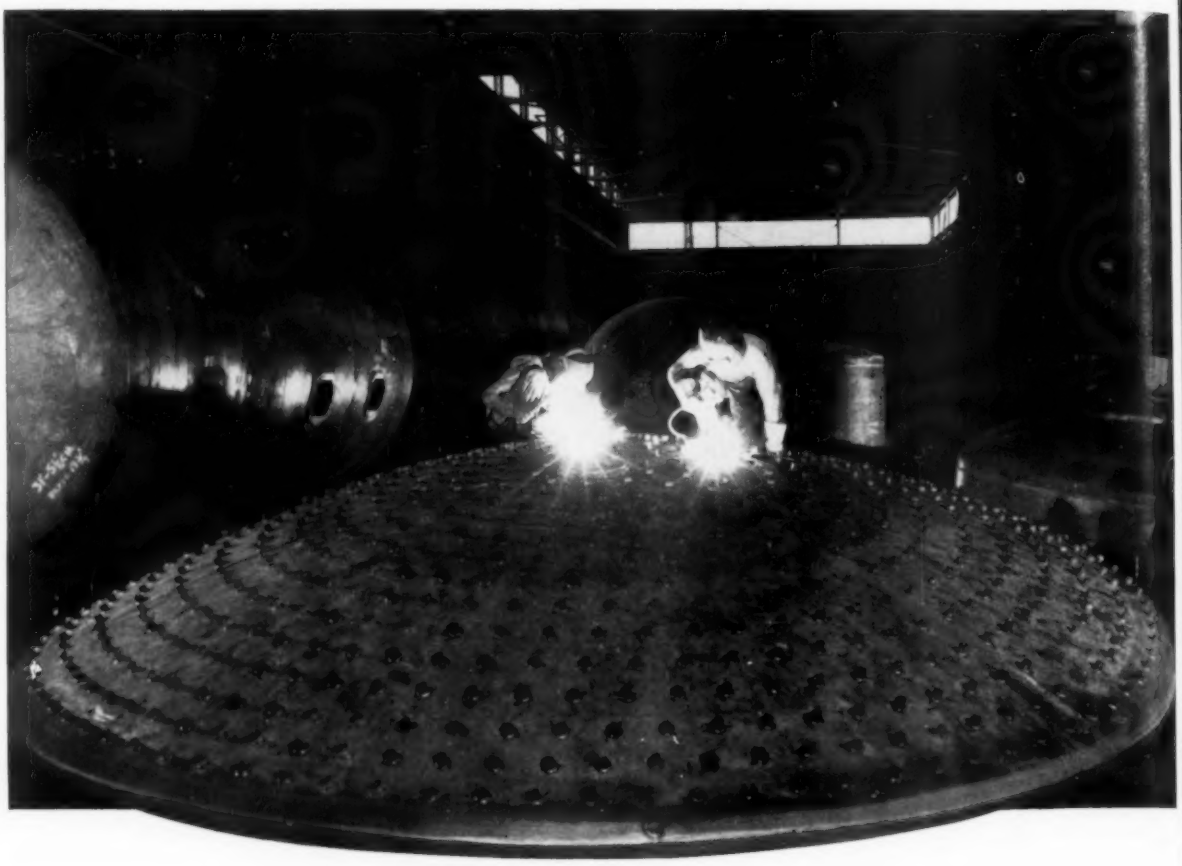
(To obtain more data on advertised products see page 280)



Why the STAYS?

Recently a large user of process equipment needed a 304 stainless steel jacketed autoclave. It was to operate at a working pressure of 110 lbs. per square inch, in the jacketed area.

The answer was a stay bolt construction (they're what you see in the picture above). This method allowed us to reduce head thickness—a technique that lowered cost considerably. This design also enabled us to improve delivery and conserve scarce nickel.

Users of alloy processing equipment (lots of 'em) are taking advantage of the skills and facilities of Chicago Steel Tank Company.

We can help you, too!

At Chicago Steel Tank Company you'll find a team of specialists that consider unusual fabricating requirements "duck soup." Why not? They're used to them. No problem with rigid customer specifications either. It's all in a day's work.

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(To obtain more data on advertised products see page 280)

Petroleum Processing

BULL PEN

How the Old Man Turned Sand Into Steam

"Black smoke came pouring out of the stack"

STEAM is something we never seem to get enough of around here. Anyhow, we never seem to get it where we need it. Sometimes I think it's one of those things that sort of creates its own demand—just run a steam line to nowhere in particular, for no special reason, and pretty soon the line's full of customers and isn't big enough to carry the load. Sometimes a lot of the customers are bootleg coffee warmers and laundry operators, but they still take a lot of steam.

We had a situation like that in our north tank field when we were trying to drive piling for an addition to the products pump house. The plans called for a whole raft of pilings and we had contracted the job to a fella with a steam rig. Trouble was, we couldn't furnish him with enough steam—he was at the end of the line and all he could get was hot water.

Of course, it was winter time—we never drive piling in good weather—and it's always cold, rainy and sloppy here. This would be cause enough for the line to put out hot water, but with a lot of tank heating coils taking off the supply, there wasn't a chance of getting enough steam for a big pile-driver hammer.

All this is just by way of explaining how we came to have this old fire tube boiler out in the tank field in the first place. Rather than run another line all that distance—it was a long way from the boiler house—we decided to rent an old vertical fire tube boiler for the duration of the job. We were able to set up close to a condensate line for water and there was plenty of No. 6 fuel oil available from a nearby tank.

So that's what we did. We set the old girl up on skids and started making steam. Sammy, the crane operator, had just wrecked his crane (again) and while the shop was reworking it, we decided to put him to firing the boiler.

Sammy would come out early and get the steam up before the contractors went to work. Then he would shut the boiler down every afternoon. Things went along fine the first day.

The end of the second day, Sammy came stumbling into the Bull Pen after he had shut down for the day. "Som'pin's wrong with that old boiler," he complained.

"What's the trouble, Sammy?" asked Cruse, head of the utilities department.

"I dunno. The steam pressure keeps dropping all day long. The harder I fire 'er, the lower the pressure drops."

Well, as I may have told you before—Sammy is our original hard luck guy around here. If anything could go wrong, it usually did when Sammy was around.

Cruse laughed it off. "Sammy, you worry too much. Just put the water and fire there and you'll get your steam."

If it had been anybody else but Sammy, I might have laughed it off, too. But with old Hard Luck, I thought it a good idea to take a look. As I said, anything can happen when Sammy's around.

Anyway, next morning, I went out to see the old boiler. Sure enough, the steam pressure was down about 25 pounds to 100 psi. The contractor couldn't stand it much lower than that. I worried about that durn boiler all day before an answer flashed. In our boiler houses, we fire gas all the time. So, naturally, we had forgotten that fuel oil will foul a tube in a hurry.

The answer was simple enough. "Sammy," Cruse said, "all you gotta do is stick a steam hose in the fire box every afternoon after you kill the fires and blow the soot out of those tubes. You'll have enough steam in the line for a job like that and you'll have clean tubes for the next day."

Next morning, I went by about an hour after the boiler was fired up. The steam presure was fine. That afternoon, Sammy was in the Bull Pen. "Som'pin's wrong with that old boiler again." He didn't like this job in the first place.

"Now what?" I asked.

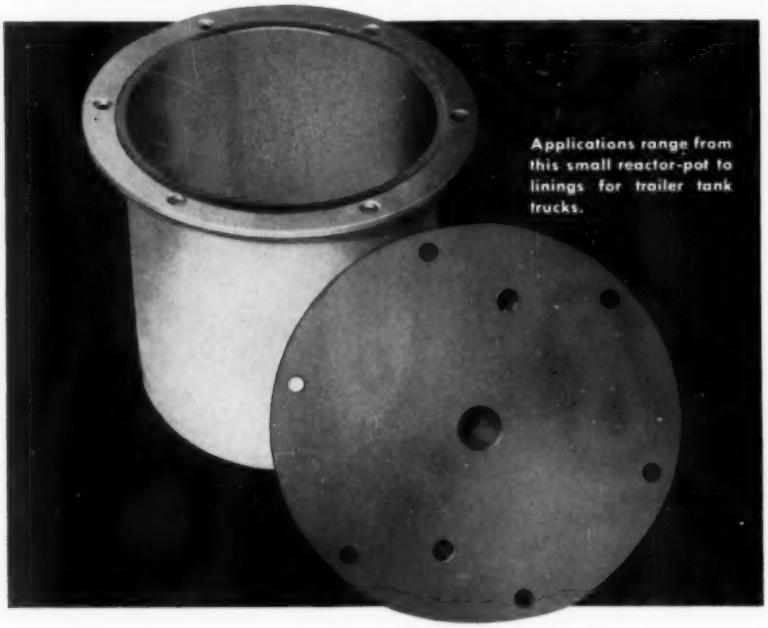
"Same thing. Steam pressure holds up fine for a couple of hours, then it starts to drop to beat hell."

Well, I hadn't expected this, but it seemed clear enough to me that we'd have to figure out some way to pipe up a permanent soot blower for that confounded boiler. I hadn't planned a fancy rig—just a line into the fire box so that Sammy could blow the tubes any time he needed to without shutting down the boiler. Anything to last out the job.

I asked Dan Mirretti to line up the

now make any vessel

CHEMICAL RESISTANT...



Applications range from this small reactor-pot to linings for trailer tank trucks.

...with KEL-F LAMINATE lining

Here is a method for making ordinary plant equipment (new or existing) resistant to gases and liquids as corrosive as fuming nitric acid—and at reasonable cost.

KEL-F Laminate comprises a tough, shatterproof, abrasion-resistant, frictionless surface of KEL-F* fluorocarbon plastic, bonded to a glass-cloth backing for maximum adhesion. It is readily cemented to any material of construction—metal, wood, concrete, etc.—and over a variety of contours.

KEL-F, being a thermoplastic resin, seams may be "heat-welded". The result is a continuous surface having zero water absorption and extremely resistant to acids, alkalies, oxidants and solvents at temperatures up to 350°F.

KEL-F Laminates are manufactured by the United States Gasket Company, pioneers and leaders in fluorocarbon plastics, and are available for installation by certified applicators. Write for further information and the name of applicator nearest you.

UNITED STATES GASKET COMPANY, Camden 1, New Jersey

*Trademark, M.W. Kellogg Co.

100 gal. Tank handling acid fluorides, lined with KEL-F Laminate.

United States Gasket *Plastics Division*

OF THE GARLOCK PACKING COMPANY

Bull Pen (continued)

pipefitters for overtime the next afternoon so that we could do the job without shutting down the contractor.

The Old Man nabbed me in the Bull Pen the next day about noon. "Why the pipefitters on overtime?" he asked. He hated overtime. I explained the situation to him.

"Hell, you don't need all that rigging to blow those tubes. Don't need steam at all." I thought he'd flipped his lid.

"I must've seen a million of these things out around the old gas plants. We fired 'em with gas, crude oil, maybe even tree leaves, I don't know—but we never worried about fancy soot blowers." I was afraid the Old Man was off on one of his wild yarns, but I was curious to see what he had in mind.

"Order a truck load of sand delivered to the boiler. We'll go out there after we eat and I'll show you how we used to clean tubes," he said. I wasn't too sure I was hearing right, but I went ahead and ordered the sand.

When we got out to the boiler after lunch, the truck load of sand was there and Sammy was having a knock down, drag out verbal row with the driver. Seems that Sammy didn't like the idea of all that sand blowing around and he wasn't going to let the guy dump his load anywhere near the boiler.

We calmed Sammy down and let the driver dump and get out. I was ready to see what the sand had to do with our troubles.

"Open the door on the fire-box, Sammy," the Old Man said. "Now watch the stack," he said as he walked over to the old steamer with two handfuls of sand. When the Old Man threw the sand in the fire-box it looked like the thing was blowing up—billows of black smoke came pouring out of the stack.

Well, it was simple enough to figure that one out, but it's a pretty neat stunt even if it is a crude way to blow soot out of tubes. The boiler draft just carried the sand right on through the tubes and we had us a sand-blasted fire tube.

As you might expect, Sammy took a pretty dim view of these crude methods, and we heard no end of griping. But everytime the old heat transfer dropped off, a handful of sand would knock the soot loose and hold the steam pressure.

Next month, the Old Man goes dramatic to save a young engineer a lot of embarrassment

(To obtain more data on advertised products see page 280)

Do you know these words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men keep abreast of technical names and processes in the petrochemical field.

Acetone

Acetone, pronounced "**ass**-eh-tone," is now produced petrochemically by a variety of routes, although it was an exceedingly important industrial chemical long before any of these were discovered. A colorless liquid of "characteristic odor" (i.e., one with which others are often compared), acetone is lighter than water and both freezes and boils well below the corresponding temperatures for that substance. It has the formula $CH_3{\bullet}CO{\bullet}CH_3$, which explains its chemical names of "dimethylketone" (the ketone group is $\bullet CO\bullet$) and "2-propanone" (descriptive of its chemical relationship to propane).

Acetone is used in large quantities for the synthesis of acetic anhydride (for cellulose acetate fibers and plastics), diacetone alcohol and mesityl oxide (both solvents), etc. It is itself a most important organic solvent for use in paints, adhesives, and lacquers, and for cellulose acetate. Another use is as an absorbent for acetylene.

Acetone is manufactured petrochemically by the oxidation of isopropyl alcohol (a propylene derivative, and itself one of the very first petrochemicals); by the oxidation of cumene (a propylene-benzene derivative); and by the oxidation of refinery gases or LPG. Propylene, of course, is a constituent of refinery cracked gases, or is produced by the cracking of propane (an LRG or LPG). Cumene oxidation yields phenol as a co-product.

While acetone has competitors for many of its uses, especially as a solvent, its versatility and relatively low price keep it in the industrial forefront. Production and consumption should continue to increase.

Naphthalene

Naphthalene, familiar to us since childhood in the form of "moth balls," is not yet a full-fledged petrochemical, but it should become one in the next few years. Pronounced "**naf**-tha-lean," it has the formula $C_{10}H_8$. Its molecular structure is that of a pair of six-carbon-atom benzene rings (C_6H_6) that share two carbon atoms, hence also possess fewer hydrogen atoms. In fact, naphthalene is the simplest type of "condensed aromatic hydrocarbon"; that is, a hydrocarbon composed of multiple benzene rings which share carbon atoms in their structure.

As we are well aware, naphthalene is a white, crystalline, flaky solid which has a strong "coal-tar" odor. In the past, it has been chiefly obtained by refrigeration of coal-tar oils. Chief uses have been as a chemical intermediate (for the synthesis of phthalic anhydride, "Tetralin" and "Decalin" solvents, chlorinated naphthalenes, etc.), moth repellent, textile chemical, fungicide, etc. So popular is one of its derivatives, phthalic anhydride (for plastics and plasticizers), that significant quantities of petrochemically derived *ortho*-xylene are being used in place of naphthalene in its manufacture.

Naphthalene is present in refinery streams, as such, but not in sufficient quantities to make its solvent extraction economic (so far). Commercially usable concentrations can be produced by special-purpose thermal-cracking processes, along with other chemicals. The main petrochemical route, however, is expected to be the hydrocracking of methylnaphthalene, which is present in relatively high concentrations in certain catalytic cracker streams.

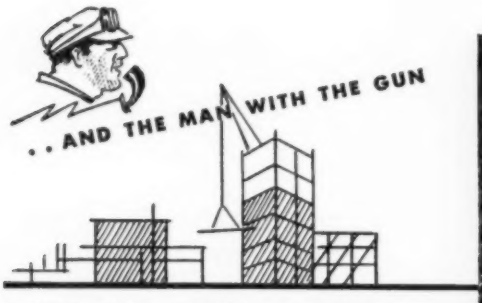
At present, petroleum-derived naphthalene would cost slightly more than the coal-tar product, especially imports. However, new European plants for the manufacture of phthalic anhydride may largely eliminate the latter source of supply, so petroleum naphthalene may soon become a reality.

NEWS in VIEWS

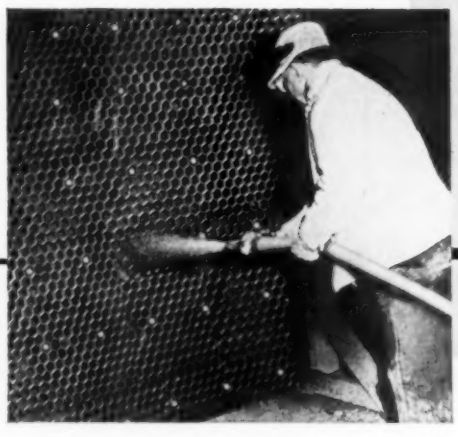
PLATINUM FOR THE FLYING-A starts journey to Tidewater's giant Delaware City refinery. The slab being held is worth about $10,000. On the dolly is another $500,000-worth of the catalyst-destined metal.

ELECTRONICS and *Mud*

Notice the ear phones on his head. He is in constant voice communication with the gunnite operator—receives instructions so that exactly the right proportions of water and dry castable are used. Result: longer refractory life in refinery vessel installations.



As he "guns" the castable-water mixture onto the retaining mesh, the operator talks to the man governing the mix—telling him when the mixture is coming in too wet or too dry. Prior to walky-talky communication, hand signals were given from hundreds of feet away.



Off-stream time hinges upon the durability of the equipment in the refinery. That's why Bigelow-Liptak has concentrated so much upon improvement of castable application to refinery vessels. As a result, you'll find B-L installations are hanging up record after record for long life and consequently helping to reduce the per-barrel cost of refined products. Remember that Bigelow supplies a complete one-source service to refineries: engineering, materials and erection. Better investigate today!

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Instrument Terminology

THIS sheet is a continuation of the glossary started in Engineering Data Sheet No. 16. These instrument terms are those commonly used in describing automatic control systems and the instruments involved. They are presented to aid discussion of this subject with some degree of assurance as to just what is being described when you listen to the strange patter of control engineers.

Term	Definition
G string	A colloquial expression for a round, solid, dielectric-coated single wire used for transmission of microwave energy.
Gain	The increase in signal power in transmission from one point to another.
Galvanometry	The technique of detecting and measuring the strength of electric currents, usually by their magnetic effects.
Gamma ray	An electromagnetic radiation from disintegrating isotopes, used for measuring process levels.
Gas chromatography	An analytical method of separating similar vapors by selective adsorption through the flow of gas through a special column.
Gate circuit	A circuit which amplifies or passes a signal *only* when certain definite input conditions are met.
Gage	An instrument for measuring some physical characteristic such as pressure, temperature, level, etc.
Geiger counter	An instrument used for detecting and counting ionized particles.
Geissler tube	A special tube used in spectroscopy. A rarified gas glows as an electric charge is passed through it.
Gimmick	A colloquial name for a small capacitor (1-5 microfarads) formed from two insulated wires twisted together.
Globar	A ceramic rod of silicon carbide used as a radiation source in infrared spectrometers.
Go, no-go detector	An instrument having only two stable indications such as a fuse, which is either intact or burned out.
Grid	A special electrode in electron tubes that controls the passage of electrons across an air-space.
Ground	An electrical conductor connected to the earth, or a large conductor whose potential is taken as zero.
Half-life	The time required for disintegration of one-half the atoms of a radio-active sample; used for classifying their rate of decay.
"hash"	Electrical noise produced by a mechanical motion such as the rubbing of motor brushes.
Head	Liquid pressure expressed as the height of a column of liquid with equivalent pressure at its base. Used in measuring liquid flow.
Heterodyne	Pertaining to the formation of a third frequency by the mixing or combining of two ac currents of different frequencies.
Hunting	see *cycling*
Hysteresis	The lag in direct effect of an applied force, resulting in different values during increases than during decreases.
Impedance	The apparent resistance in an ac electrical system, expressed as the ratio of the emf to the current.
Index	The pointer on an indicating instrument, which shows the value of the reading. It may also refer to the value of the set point on a controller.
Indicating instrument	Any measuring device which is read by observing the position of a pointer on a scale. It differs from null instruments which require adjustment for final reading.
Independent variable	A condition or quantity which is not dependent for its value on other process variables; in boiling water the temperature is not dependent on the pH value of the water.
Inductance	The property of an electric circuit to induce an electromotive force in its own or a neighboring circuit.
Infrared analysis	A method of detecting small quantities of vapors by their selective absorption of infrared radiation.
Infrared radiation	An electromagnetic radiation with a frequency ranging from 1 million to 500 million megacycles. It falls between that of visible light and microwave radar.
Infrasonic	Describing a device or system operating at frequencies below the audio-frequency range (less than about 20 cycles/sec).
Instruction	Information which, when properly coded and fed into a digital computer, causes it to perform one or more of its operation.
Integrator	As applied to a flowmeter, it is a device that computes the total flow over a period of time, based on the rate of flow recorded by the flowmeter.
Input	The initial signal fed into a control system or into a computer.
I.R.	Abbreviation for *infrared*.
Inverter	A device for converting dc into ac; or, it may mean a gas-filled electron-tube circuit for doing the same thing.
Jitter	Small, rapid variations in a wave form due to mechanical disturbances, changes in the voltages, component characteristics, etc.
Lag	The slow rate of response in a control system between the cause and effect. It may be due to large process quantities, long signal transmission lines, slow chemical reactions, or slow response in the instruments themselves.
Light valve	A device whose light transmission varies with an externally applied electrical quantity, such as current or voltage.
Limiter	A transducer whose output is constant for all inputs above a critical value.
Linear	A relationship in which change in one related quantity produces an exactly proportional change in the other.
Load cell	A weighing transducer that converts force on a loading platform into proportional hydraulic pressure for actuating an indicator, recorder or controller.
Load change	A change in operating conditions which requires a change in the flow of the controlled medium to maintain the desired control point.
Load error	See *offset*

For more definitions, turn the page . . .

Instrument Terminology (continued)

Term	Definition
Logger, data	An automatic recording system that receives instrument signals and converts them into typed figures.
Manipulated variable	A quantity or condition that is varied by an automatic controller so as to affect the value of the controlled variable.
Magnetostriction	A phenomena which causes a metal rod to change its length when subjected to a longitudinal magnetic field.
Mass spectrometer	An analytical instrument for identifying substances by sorting electrified particles according to their ratios of mass to charge.
Microwave	An electromagnetic wave with a frequency between about 1000 to 300,000 megacycles—a wavelength of 30 cm to 1 mm.
Memory	Any device into which information can be introduced and later extracted.
Modulation	The variation of some characteristic of a wave form by imposition of another wave form.
Motor-operated	As applied to a control valve, this identifies it as being positioned by an air, electric or hydraulic powered device (a motor).
Multiposition control	A type of control response which selects one of several rates of corrective action depending on the deviation of a process variable.
Negative bias	A voltage that makes the control grid of a vacuum tube negative with respect to its cathode, which also has a negative value.
Neper	A unit expressing a scalar ratio of two currents or voltages, the number of nepers being the natural logarithm of such ratio.
Neutral zone	See *dead zone*
Noise	Any unwanted disturbance within an instrument circuit; a form of interference.
Null-balance	A method of measuring that directly compares an unknown quantity with a like known value, usually after balancing an electrical circuit to zero (null).
Offset	A sustained deviation due to an inherent characteristic of positioning controller action. It is the difference existing at any time between the control point and the value of the controlled variable.
Optimalize	To create the most advantageous conditions for processing, through automatic control.
On-off control	A control system in which the final control element has only two positions to select from.
Oscillation	One complete period of vibratory motion.
Overlapping	A trouble encountered in spectroscopy when the long-wave end of a diffraction spectrum coincides with the short-wave end of the spectrum of the next higher order.
Overload	A current, voltage or power level applied to an instrument beyond which permanent damage will occur.
Parallax	The apparent change of position of an instrument pointer due to a change in the position of the observer. A mirrored surface on some instrument faces removes this difficulty.
Paramagnetic	Identifies any material that is better than air as a path for magnetic lines of force.
Parameter	An arbitrary constant to which any numerical value may be assigned. It differs from a fixed or absolute constant, or a variable.

Term	Definition
Peak	The maximum instantaneous value of an alternating quantity.
Phase displacement	The fractional part of a cycle by which two similar alternating quantities are displaced so that they do not coincide.
Period	The time in minutes of one complete cycle of oscillation.
Pilot-operated	A device in which the energy transmitted through the primary element is either supplemented or amplified by energy from another source.
Photoelectric	The term describing materials or instruments which emit electrons when subjected to light or high frequency radiation.
Photometry	The measurement of the brighteness of light.
Photophoresis	A phenomenon in which a strong beam of light gives a directional motion to fine particles or liquid, suspended or falling in a gas.
Piezoelectric	A term describing the production of electric charges on the face of certain crystal materials when subjected to mechanical stress.
Positioning action	Action in which there is a predetermined relation between the value of the controlled variable and the position of a final control element.
Potentiometer	An instrument used to measure or compare electromotive forces. Sometimes labeled a "pot."
Power gain	The ratio of power that a transducer delivers to a specified load to the power absorbed by its input circuit; usually expressed in decibels.
Power pack	A power supply unit that converts available line or battery voltage to that required for operating an instrument.
Pre-act response	A response which gives an additional valve movement, proportional to the rate of pen movement.
Precision	The quality of being exactly defined. As applied to measurement, it is the degree of reproducibility among several independent measurements of the same true value under specified conditions.
Primary element	That portion of the measuring means which is first subjected to the instantaneous condition of the process variable.
Process lag	Any delay in bringing information of a change in a variable to the primary sensitive element of an instrument. Includes capacity lags, distance-velocity lag and reaction lag.
Process variable	A physical quantity or quality related specifically to a process; it varies with time.
Proportional band	The range of measured values needed to cause maximum possible change in the final control element setting; i.e., the amount of pen movement necessary to give full valve movement. Usually expressed as % of full scale range.
Proportional response	The type of action which adjusts the final control element in proportion to the deviation of the process variable.
Proportional-position action	Action of a controller in which there is a continuous linear relation between the value of the controlled variable and the position of the final control element.
Proportional control plus reset	A proportional control system that also automatically resets the set point in order to control the degree of valve opening.
Proportional control with derivative	A proportional control system that moves the final control element (a valve) in proportion to the *rate of change* of the measured variable.

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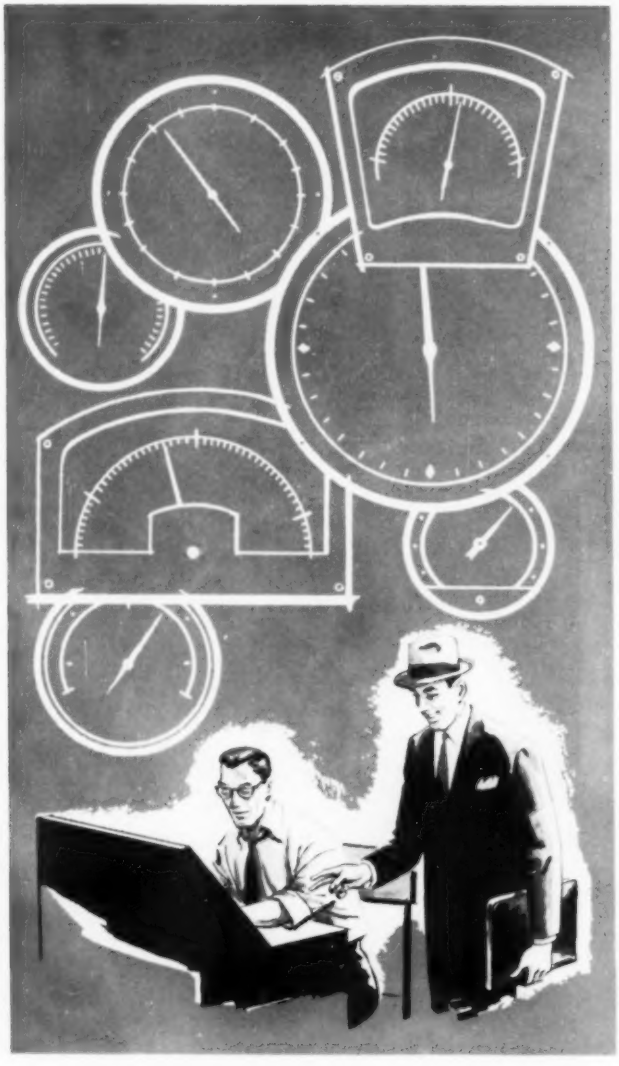

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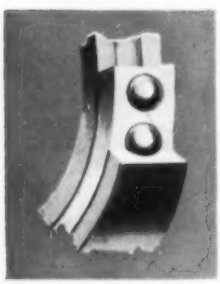

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PERSONALS

Kennedy elected new WPRA prexy

NEW OFFICERS were chosen by Western Petroleum Refiners Assn. at its recent annual meeting. Fourth from left is the new president, Harry J. Kennedy, vice-president of Continental Oil Co. Others shown, all new vice-presidents, are (l to r) J. A. Vickers, Vickers Petroleum Corp.; Rex Blazer, Allied Oil Co.; W. J. Carthaus, Great Northern Oil Co.; Walter Famariss, Jr., Famariss Oil & Refining Co. Not shown here is F. L. Martin, Suntide Refining Co., who was re-elected a vice-president of the group. Kennedy succeeds Reid Brazell, Leonard Refineries, who has been president since 1955.

C. W. Stose has been named general superintendent of the process division of Atlantic Refining Co.'s Philadelphia refinery. Stose was previously general manager of Atlantic's crude oil purchases and sales activities.

W. O. Hoffman, who was superintendent of the refinery's mechanical department, has been named general superintendent of the services division and will direct all maintenance, power, and stores activities.

A. D. Togna has been named supervisor of the newly established products testing department of the Texaco Research Center at Beacon, N. Y. He was formerly assistant supervisor of the analytical and testing department. He joined Texaco in 1943, after receiving a B.S. in chemistry from the University of Michigan.

Samuel P. Dickens has been promoted to supervisor of project evaluation research at Beacon. He was previously assistant supervisor of fuels research at the Port Arthur-Port Neches laboratories. He holds a B.S. in chemical engineering from North Carolina State College and began with Texaco in 1943.

W. R. Smith has been named technical assistant for the Texaco Development Corp., licensing and patent subsidiary. He was formerly assistant supervisor of chemicals research at Port Arthur-Port Neches labs. Smith holds a B.S. from Miami University and M.S. and Ph.D. degrees from Western Reserve University.

W. W. Lowe, vice-president of Cities Service Petroleum, Inc., has been elected to the board of the parent Cities Service Co. Lowe is also a director of Cities Service Refining Corp. and Cities Service Research and Development Co., as well as president of Wolverine Pipe Line Co.

Dr. Donald E. Burney and **G. Hans Weisemann** have been promoted to section leaders in the chemical products division of the Standard Oil Co. (Ind.) research department. **Dr. Philip H. Towle** has been made group leader.

James F. Grutsch has been appointed group leader in the heavy oils, asphalt and ammonia technical service division of the research department. He holds a B.S. and M.S. from Indiana University and joined the company in 1952.

Burney is a graduate of the universities of South Dakota and Illinois. He began with Indiana Standard's research department in 1941 and has been a group leader since 1947.

A graduate of Iowa State university, Weisemann joined the company in 1944 and has been a group leader in the research department since 1948.

Towle has been with the company since 1948 and most recently worked as a patent advisor. He is a graduate of the University of Illinois and of Ohio State.

Julian A. Rogers has been made head of the manufacturing department of W. R. Grace & Co.'s polyethylene plant at Baton Rouge, La. He was formerly head of the ammonia department of the Grace Chemical Co. Rogers is a mechanical engineering graduate of Southern Methodist University.

Dr. Carroll Karkalits has been named supervisor of research for the Petro-Tex Chemical Corp. of Houston.

A graduate of Rice Institute in 1938, with a B.S. in chemical engineering, Karkalits took M.S. and Ph.D. degrees at the University of Michigan. He has worked in industry with American Cyanamid, at Bound Brook, N. J., and Food Machinery and Chemical Corp., Princeton, N. J.

Petro-Tex is currently completing a research lab and pilot plant at the Houston headquarters.

Charles Swoope, recently made general superintendent of the Esso Standard Oil Co. Bayonne refinery, has been named manager of the Baltimore refinery, a new post. H. G. MacBurney continues as general superintendent at Baltimore. The change took place as a result of Esso's discontinuance of the office of manager, southern East Coast refineries. **Stanley Wuchter,** who last held the title of manager, has been appointed consultant pending his retirement in September. Swoope will not be replaced at Bayonne.

Charles A. Brown, general superintendent of the Charleston plant, has become manager of the plant.

Harold J. Rose has been appointed assistant general manager of the company's chemical products department. He was formerly coordinator of chemicals research for Esso Research and Engineering Co.

At Bayonne, **Joe Murphy,** who was general superintendent, has become assistant to the plant manager. He has been at Bayonne since May on rotational assignment as assistant general

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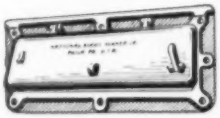
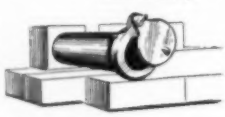


Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.

Fuel Oil Suction Strainer, single type. Large basket area insures low pressure drop; cover and basket easily removed for cleaning.

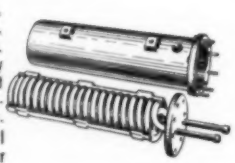
Wide-View Peephole, safety, curtain type. Cobalt glass removed to show bearing surface for curtain. Curtain halves are interlocked—open simultaneously.

Ignition Port with Refractory Tile No. M896 . . . for use with standard 3" pipe. Also serves as a peephole.



Furnace Relief and Access Door, heavy construction, practically air tight. Door casting correctly weighted, lined with plastic refractory retained by imbedded grill; with observation port and cover.

Fuel Oil Heater, Self-Cleaning, Spiral Coil Type. High oil velocity in coil, resultant turbulence prevents carbon formation. No internal connections or joints.



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Personals (continued)

superintendent. His permanent assignment since 1944 had been general superintendent at the Everett refinery.

Operations superintendent of the Bayonne plant is now **Ed Hughey,** previously head of the manufacturing and fuel products terminalling department.

Three men in petroleum research have been given Certificates of Appreciation by the American Petroleum Institute Division of Refining. Awards were made at the mid-year meeting in Philadelphia, May 13-16. Those receiving awards were:

Dr. Barnard

Dr. Field

Dr. Hill

D. P. Barnard, research coordinator of Standard Oil Co. (Ind.), Chicago.

Hugh W. Field, vice-president and general manager of research and development, Atlantic Refining Co., Philadelphia.

J. Bennett Hill, pioneer oil chemist and recently retired director of research and development for Sun Oil Co., Marcus Hook.

Eleven supervisors have been appointed at Tidewater Oil Co.'s new refinery at Delaware City. The men, and their positions were:

William H. Bacon, group leader in knock testing,

Everitt T. Chandler, Carl F. Lewis, and **James Jeffries, Jr.,** general services shift supervisors,

Arthur T. Dundas, chief estimator, engineering,

Dr. Jack M. Gillette, group leader, spectroscopy,

Andres J. Juhas, group leader in the analytical section,

Thomas J. Magner, senior engineering draftsman,

James Victor McCool, supervisor of safety,

Aniello Vicedomini, group leader, physical testing.

Mansell S. Richards, oil scheduler in the utilities oil dispatching and sulfur recovery department.

Bacon, Chandler, Lewis, Gillette, Vicedomini and Richards came directly from the Bayonne refinery. Jeffries, Dundas, and Magner worked with C. F. Braun on the project. Juhas transferred to the refinery from the company's Avon, Calif., refinery. McCool joined Tidewater after serving as safety inspector for C. F. Braun and Co. at the Delaware site.

H. C. Packard, of Shell Oil Co., New York, has been named chairman of a new American Petroleum Institute subcommittee — on Petroleum Liquid Quantity Measurement. Packard is chief analyst of transportation and supplies—loss control. The new group has been formed to end the duplication of effort by technical societies in the measurement of petroleum. It will be concerned with setting policy as to what groups should test and set standards in which areas. The subcommittee grew out of a symposium on measuring, sampling and testing of crude and petroleum products held 2½ years ago. Members are:

A. H. Newberg, chief engineer, Service Pipe Line Co., Tulsa, who has been named vice-chairman,

Elmer Mattocks, API department of technical services, secretary,

S. D. Dalton, manager, refinery engineering division, Socony Mobil Oil Co., New York,

F. M. Dawson, vice-president, supply and distribution department, The Texas Co., New York,

C. W. Hubbell, assistant manager, engineering department, Phillips Petroleum Co., Bartlesville,

H. F. Huf, administrative manager, engineering and construction department, Atlantic Refining Co., Philadelphia,

J. H. McClintock, coordinator of oil loss prevention, Esso Standard Oil Co., New York,

R. K. Paine, manager of pipelines, Standard Oil Co. of California, San Francisco,

Paul Siecke, director, process design division, Gulf Oil Corp., Pittsburgh,

L. S. Wrightsman, coordinator, products pipeline operations, Humble Pipe Line Co., Houston.

Donald H. Ernest has been named project engineer and plant superintendent of the Amoco Chemicals Corp. plant to be built near Joliet, Ill. He was previously a member of the Seymour research staff. Ernest, a gradu-

ate of Marquette University with a degree in chemical engineering, joined Standard Oil Co. (Ind.) in 1954. He transferred to Amoco Chemicals last March. Previously he had worked at Carnegie Illinois Steel Co., Universal Oil Products Co., and Franklin Supply Co.

Dr. Kasch

Mr. Peeler

Dr. John E. Kasch and **Winston S. Peeler** were incorrectly identified by the photos shown with their notice of promotion in the March Personals. This error is corrected in the photos above.

L. D. Hoblit, assistant director of Dow Chemical Co.'s organic pilot plant laboratory, has been named laboratory director of the Louisiana Division. He is in charge, in the new post, of the central analytical laboratory and of research for the Division.

He holds a B.A. in chemistry from Texas Christian University, Class of 1941.

Dr. William J. Sparks has been appointed scientific advisor to Esso Research and Engineering Co. The new post was created as part of the company's policy of "according recognition and prestige to the abilities and achievements of individual scientists and engineers." Sparks has been director of the chemicals research division since 1946 and holds more than 100 patents. He is the co-inventor of butyl synthetic rubber.

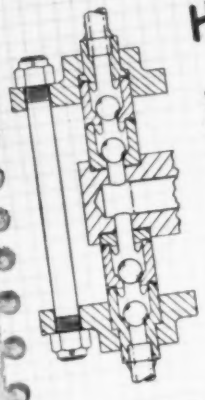
In his new post he will survey scientific activities in industry, government, universities, and other bodies and will recommend research projects to Esso Research. He will be associated with the office of scientific liaison.

Dr. Miller W. Swaney has been appointed coordinator of chemicals and lube oil processes, succeeding **Harold J. Rose,** who has been transferred to Esso Standard Oil Co. Swaney was previously director of the products research division. He holds a B.S. and M.S. from Vanderbilt University, and obtained his Ph.D. from Purdue University.

Dr. Robert W. Krebs has become

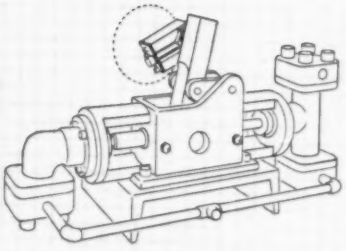
advanced design in high pressure pumps

High Pressure Valves--



of ball-guiding cone seat type. (Under high pressure conditions, balls do not seat themselves properly on conventional ring type seats, without guides.) Pressure drop is in direct ratio to ball rise (patent applied for). Valve illustrated is an easily disassembled design for pressures to 3,000 psi. Other valves, totally enclosed in forged steel, for pressures to 35,000 psi. Balls may be spring-loaded for down stream pumping and viscous materials (up to 30,000 SSU).

Differential Pressure Heads--



cut pump power requirements to a fraction by utilizing high suction pressures, when available.

These heads hydraulically balance the pistons using suction pressure. Thus, it is only necessary to power the pump for the difference between available gallon-pounds of suction and required gallon-pounds of discharge. Example: to add 5 gph of nitric acid at 5000 psig to 4500 psig liquid isotope—power requirement without differential pressure head is 2 hp., with differential pressure head it is only .5 hp., or a saving of 1.5 hp.

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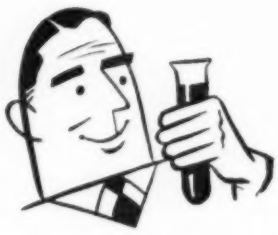

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director of the chemicals research division, replacing Dr. Sparks. He has been associate director of the Baton Rouge laboratories and is succeeded in that post by **Dr. Fred W. Banes,** who was acting associate director.

Ed Upchurch and **Roger Bock** have been promoted to group heads. Upchurch has been named to a group in the engineering development section, Bock to one in the process design section.

Charles E. Webber is this year's recipient of the Hanlon Award, given annually by the Natural Gasoline Association of America for outstanding service to the industry. Webber is technical advisor to the vice-president of Sun Oil Co. The citation recognizes his "valuable service to the industry in times of national crisis, his personal contributions to the technology of natural gasoline operations, and his stimulating and constructive leadership in cooperative group activities which speeded progress toward desired and greatly needed technical objectives."

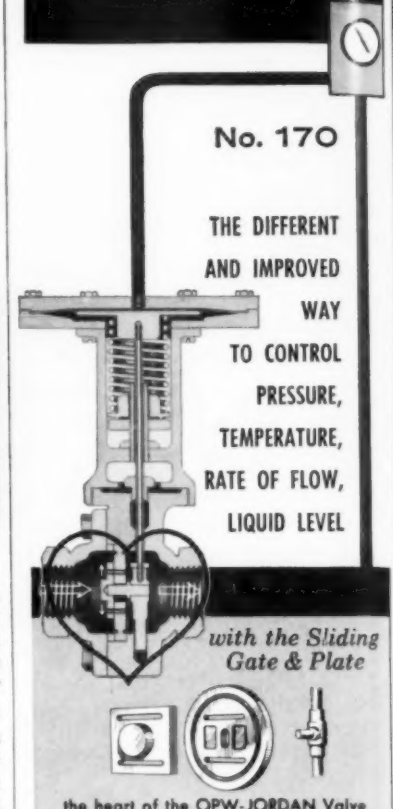
Mr. Webber

Webber holds a B.S. and M.S. in chemical engineering from Louisiana State University. The latter degree he received in 1934. He worked first with Humble Oil & Refining Co., in Houston, and then, during World War II, with the Natural Gasoline Division of the Petroleum Administration for War. After the war he joined Sun Oil Co., as an assistant to the late James E. Pew, and was connected with its natural gas division. In 1951 he returned to the Petroleum Administration for Defense for one year. Today he belongs to the Military Petroleum Advisory Board. He took his present post at Sun in 1955.

J. Lee Marsh has been appointed vice-president in charge of development for Carbide and Carbon Chemicals Co. He was director of engineering for the company. Marsh holds B.S. and Ph.D. degrees from Yale University.

L. W. Newton has been made assistant to the research vice-president of the company. His work has been in organic acids, plasticizers, and nitrogenous substances, and he was last assistant superintendent of research. Newton holds a B.A. from the University of Wichita and a doctorate in chemistry from Harvard University.

OPW-JORDAN diaphragm motor valve



the heart of the OPW-JORDAN Valve

- POSITIVE, DEAD END SHUT-OFF
- PRECISE, ACCURATE CONTROL
- WIDE RANGEABILITY
- SELF CONTAINED OR CONTROLLER OPERATED

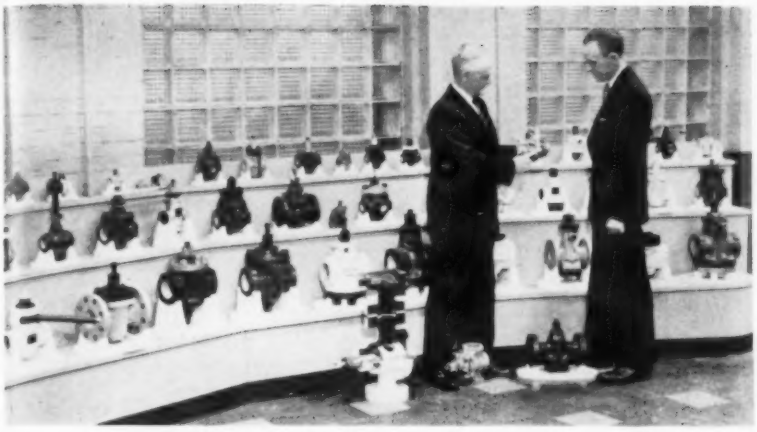
The No. 170 Diaphragm Motor Valve, incorporating the use of OPW-Jordan's unique Sliding Gate, offers straight through flow, with modulation through the valve opening. Seating surfaces of hardened stainless steel, precision lapped to light band flatness tolerances insure a positive leakproof shut-off. Wire drawing minimized or eliminated. Compact, space-saving, the No. 170 offers the full advantage of accurate control and desired sensitivity. Durably constructed for hard continuous usage, the basic design and exclusive features of this valve make it outlast and outperform ordinary diaphragm motor control valves.

Free Bulletin J-170 gives complete details, flow curve and capacity tables.

JORDAN CORPORATION

DIVISION OF OPW CORP.

6013 Wiehe Road
Cincinnati 13, Ohio
ELmhurst 1-1352



Rockwell opens "Museum of Valves"

THE HISTORY of the lubricated plug valve is on display at what must be one of the most unusual museums open. Rockwell Manufacturing Co. assembled the exhibit at its Barberton, Ohio, manufacturing plant and included cutaway and working models of every design and type since Sven Nordstrom's original 40 years ago.

In the photo, Ernest Fallows, assistant general manager of the plant, shows a cutaway model to Thomas Gettig, assistant to the vice-president of the Meter and Valve Division.

An interesting feature of the museum is the display of valves made by other companies, which lines one wall of the room. Drawings above the working models show how these valves were influenced by the original Nordstrom design.

New quarters for Tracerlab

A new building has been opened in Waltham, Mass., to consolidate the East Coast operations of Tracerlab, Inc., manufacturer of nuclear and X-ray equipment and a consultant in radiation. The company was previously housed at seven separate locations in Boston. The new facilities include 15 chemical, physics and radiochemical laboratories, specially constructed for the handling and storing of radioisotopes; manufacturing space; engineering and research offices; and sales offices. Tracerlab's film badge service for East Coast radiation users will also be at the new building.

Rockwell shifts valve sales force

Herman Gottwald and Donald C. Morgan have been named assistant vice-presidents and product managers in the Meter and Valve Division of Rockwell Manufacturing Co. In addition, Robert A. Johnson succeeds Gottwald as eastern regional sales manager, and Thomas O. Carson takes Morgan's former job of central regional sales manager.

Gottwald has become product manager in charge of valve sales; Morgan is product manager of gas products sales.

Broggini named head of Badger

New president of Badger Manufacturing Co. is A. J. Broggini, who succeeds George C. Hargrove. Hargrove is retiring from active service. In addition to his new duties Broggini will remain chairman of the executive committee. He is also a director.

Mr. Broggini

Broggini is a chemical engineering graduate of the University of Michigan, class of 1934. He belongs to the American Institute of Chemical Engineers, the American Petroleum Institute and Tau Beta Pi.

Kaspark is Wolverine manager

Wolverine Tube, a division of Calumet & Hecla, Inc., has made Albert R. Kaspark manager of technical sales. He has served in various sales posts for Wolverine during the past 18 years. His most recent assignment was manager of steel sales. He is headquartered at the division's general sales offices in Detroit.

B&W names Nielsen president

M. Nielsen has been elected president of the Babcock & Wilcox Co., succeeding Alfred Iddles, who is retiring after serving as president since 1948. Nielsen has been executive vice-president for the past two years.

Mr. Nielsen

Nielsen joined B&W in 1924 as a construction worker. In five years he rose to district inspector, and in 1937 was made district erector in charge of the Cincinnati district. He moved into marine boiler work after that and was made superintendent of marine erection in 1939.

In 1953, after successive promotions, Nielsen was elected vice-president in charge of boiler division manufacturing. A year later he became head of the entire division and a company director.

Personnel changes

Harshaw Chemical Co.—William A. Harshaw II to vice-president in charge of research; Earl C. Ray, from Houston branch manager to manager of market development; Lawrence A. Latour, from assistant manager of the catalyst division to Houston branch manager; Dr. William D. Stillwell, from director of field research to product manager of catalysts; Hugh B. Webster to branch manager and Bryan T. Bostwick to assistant branch manager, both in Philadelphia; Elwood J. Baldwin to southeastern district manager, with temporary headquarters in Atlanta.

Consolidated Electrodynamics Corp.—Charles P. Holderbaum to manager of a new district sales office in Pittsburgh, at 708 Franklin Ave. The new district comprises western Pennsylvania and most of West Virginia. Holderbaum holds a B.S. in mechanical engineering from the University of Pennsylvania; Herbert C. Waldeck to manager of the New York district office, succeeding Frank E. Chase,

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WRITE FOR BULLETIN 350

PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

BUILDING a 3-million-volt Van de Graaff accelerator at the new headquarters and manufacturing facility of High Voltage Engineering Co. at Burlington, outside Boston. Plant consolidates activities of the 11-yr-old company. The $2-million building is equipped with enough test vaults to operate 16 accelerators at once. Each vault has 4-ft-thick walls and is sealed off when in use by a 20-ton concrete block door. High Voltage is the only firm making Van de Graaffs and counts several oil companies among its customers.

who has been appointed sales manager of the Glendale division. Waldeck attended New York's City College.

Ehrhart & Associates, Inc.—D. R. Turner to project manager, with headquarters in Los Angeles.

Lunkenheimer Co.—Vincent P. Mahon, sales representative, has been transferred from Chicago to Houston.

Geigy Industrial Chemical Division—J. C. Findlan to sales manager. This is a division of Geigy Chemical Corp.

Wolverine Tube Div.—John V. Betz to sales representative in the New York area; William Bothwell to sales representative in Kentucky, southern Indiana and surrounding area.

Universal Oil Products Co.—Glenn F. Stednitz, safety director of the Riverside-McCook facilities, has been elected secretary of the petroleum section, Great Lakes Division, of the National Safety Council. Division covers 11 states and promotes industrial safety through exchange of information on oil industry operations.

Ethyl Corp.—G. T. Mercier, acting superintendent of operations at Houston, to superintendent.

Penberthy Manufacturing Co.—Howard E. Strohmaier to general sales manager. He has been with the company for more than 20 years.

National Aluminate Corp.—Dr. William P. Hettinger, Jr., to research director of the catalyst division. He was formerly director of the catalysis division of Sinclair Research Laboratories.

Hills-McCanna Co.—Philip T. Rogers to product sales manager in the valve sales department; P. R. McCloud to product sales manager in the pump sales department; H. P. Orlebeke, also in pump sales, to chief engineer. Or-

Suppliers (continued)

Iebeke was once an engineer with Standard Oil Co. (Ind.)

Expansion, transition

Procon, Inc., has added a two-story office building to its quarters in Des Plaines, Ill. Executive, sales and administrative engineering operations offices are located in the new building.

Baker & Co. has established a separate instrument division to make and sell the company's nitrogen generators, gas purifiers and dryers, and gas indicators. I. W. Sheppard is sales manager of the new division; E. J. Emerson is chief engineer. Address is 207 Grant Ave., E. Newark, N. J.

Dow Chemical Co. has begun construction of terminal facilities at Baltimore, Md., for storage and distribution of 50% caustic soda solution. Two leased tankers—Marine Dow-Chem and Marine Chemist—will supply the terminal from the Texas Division plant.

Crane Packing Co. has opened a facility at Vandalia, Ill., to augment the home plant's output. Initially the 30,000 sq ft facility will make mechanical seals for pumps, compressors, and other equipment.

Beckman Instruments, Inc., opened its Computation Center in Los Angeles recently. The $250,000 system houses an analog computer.

DeZurick Corp. is new name of DeZurick Shower Co., manufacturers of an eccentric-type, non-lubricated plug valve. Company has completed several substantial expansions in its Sartell, Minn., plant.

Delta Tank Mfg. Co. has opened a new equipment sales and stocking point in Houston. It is located at 2606 Knobloch St.

Branches, distributors

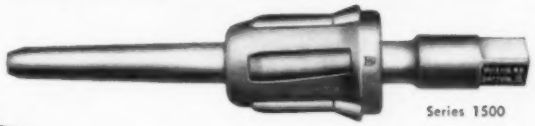
U.S. Stoneware Co. has opened a new West Coast office at 908 S. Atlantic Blvd., Los Angeles. Office is in charge of Kenneth Bullock, who has been an assistant sales manager in the process equipment division at Akron, O.

Hills-McCanna Co. has appointed Neptune Supplies, Inc., New Orleans, as stock distributor; McRae Engineering, Ltd., Toronto, has been named exclusive representative in Ontario and Quebec provinces.

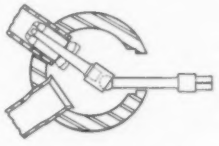
WIEDEKE

THE QUALITY NAME IN TUBE EXPANDERS . . . SINCE 1892

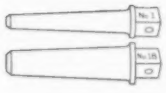
Tube Expanders for Water Tube Boilers



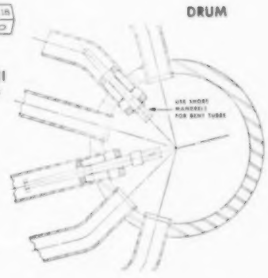
Series 1500



With Short Mandrel; Universal Joint Drive for Superheater Header

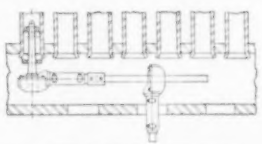


Short Mandrels—all sizes, in 3 lengths



DRUM

With drum Mandrel for straight tubes; use short Mandrels for bent tubes.



With Short Mandrel and Right Angle Gear Drive; for round or square headers.

#38

IDEAL

Continuous research and development in Tube Expanders, Tube Cutters and Operating Accessories for condensers and boilers has been going on at The Gustav Wiedeke Company since 1892. The IDEAL Trademark is your guarantee of quality. *Confidence* is your assurance that your job will be done *RIGHT* . . . when you use WIEDEKE Specialized Products. Wiedeke Distributors in principal cities. Write for new General Catalog 81.

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Permanent Reference Reports

JUNE Low Temperature Insulation

OCTOBER Nuclear Radiation

DECEMBER Furnaces

Industry Reports

JULY Tidewater, Delaware City Refinery Issue

SEPTEMBER Annual Petrochemicals Issue

Ad Closing Dates—20th of month preceding date of issue

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(To obtain more data on advertised products see page 280)

AGAIN—Blaw-Knox points the way

. . . this time to ASHLAND's 6,000 bpd source of high octane gasoline

The catalytic reforming and hydrogen desulfurization unit, now in operation, is the latest of eight Blaw-Knox units which are operating successfully in the petroleum industry—to supply high octane gasoline for today's high compression motors. Engineered, constructed and installed by Blaw-Knox, it provides a capacity of 6,000 bpd in the Buffalo Refinery of the Frontier Oil Refining Division of Ashland Oil and Refining Company.

The wide experience of Blaw-Knox engineers in catalytic reforming, as well as other petroleum and chemical processes, is always available to you. We welcome the opportunity to discuss your proposed modernization, expansion or new plant projects with you—and to offer our recommendations.

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(To obtain more data on advertised products see page 280)

Patents in months instead of years?

THE U.S. Patent Office is testing its long talked about project for "automating" patent searches. This first test, limited to searches on 350 steroid patents, is trying both computer and less expensive punch-card equipment.

If the project is successful, the chemical industry will be the first to benefit. The rigorous and consistent identification of chemical compounds lends itself to mechanical searching.

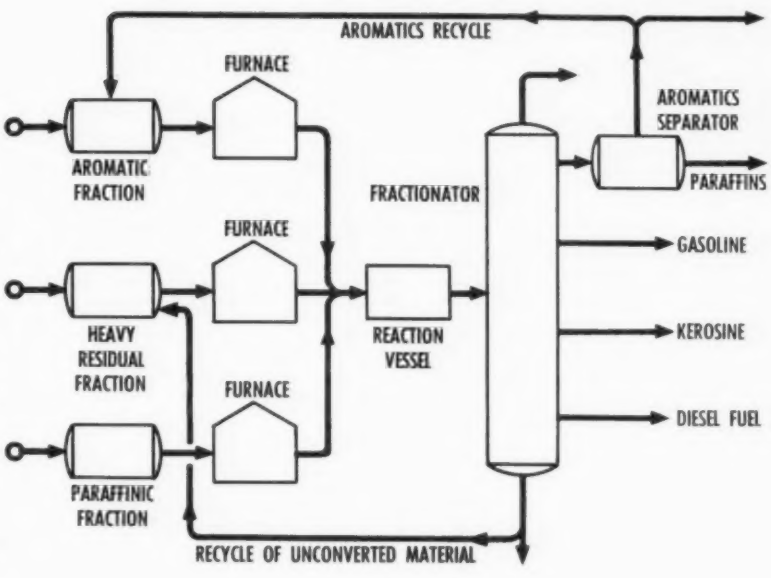
Manual patent searches are tedious, requiring 4-6 hours for the 350 steroid patents. The punch-card system cuts this time to 2-3 minutes (including machine set-up), while computers need only a fraction of a second.

Fond hope of the Patent Office is to reduce the 8-12 months now needed to search for a patent application, making it only a few weeks. The 3½ years it now takes to get a patent could conceivably be reduced to a few months, if machine searching is successful.

More $ for patent examiner?

CONGRESS and the President are talking a wholesale overhaul of the Civil Service System as an aid in getting more scientists and engineers into federal service. The Patent Office would get a real assist from such a program, because it employs hundreds of scientists and engineers as examiners.

Bills have been drafted in Congress to raise patent examiners salaries from the present $4880-$11,610 range to a shade below the $5250-$20,000 paid for comparable jobs and experience in industry. However, the current Congressional "economy drive" will probably delay such legislation until next year, at the earliest.



No coke in resid cracking

THE problem of cracking residual petroleum fractions, without excessive coke formation, can be solved with a 3-stream system, according to Sun Oil Co. in U.S. Patent 2,782,145.

As shown in the flow diagram, heavy resid, a refractory aromatic, and a straight-run paraffinic naphtha are combined before the cracking vessel. Resid is heated to a temperature below its cracking temperature (about 700°F). The aromatic fraction is heated to below its decomposition temperature, but to a temperature above that at which the resid would crack (about 1150°F). The straight-run, 400-500°F boiling range, paraffinic naphtha is heated sufficiently to cause incipient cracking of this material (about 850°F).

The three heated streams are mixed substantially simultaneously and sent to a reaction vessel, whose main purpose is to insure adequate mixing and reaction time. Contact with the hot streams (aromatics and paraffins) raises the resid to above the cracking temperature.

The process can be modified to use cracking catalysts, in which case the mixture should contact the catalyst immediately after mixing the three streams.

Coke formation during the reaction is negligible. The reaction products are then separated as desired, with recycle of aromatics and unreacted (or under-reacted) resid.

Xylene isomerization

Individual xylene isomers, and non-equilibrium mixtures of xylene isomers may be converted into an equilibrium mixture by vapor-phase isomerization in the presence of hydrogen, according to California Research Corp. in U.S. Patent 2,784,241.

Hydrogenation-dehydrogenation catalysts (Group V, VI or VII metals, oxides or sulfides on a carrier) are used at 12-18 atmospheres for 700°F temperatures, or 60-100 atmospheres for 900°F temperatures. Space velocities are 0.1-10 v/hr/v.

Better cat reforming

Catalytic reforming at relatively low hydrogen partial pressure, giving a much higher level of conversion without a corresponding increase in coke is claimed by Standard Oil Co. (Ohio) in U. S. Patent 2,784,147.

The trick is to use a co-precipitated alumina-chromium oxide catalyst with a small amount of an oxide of germanium, indium and gallium. The third element (in addition to alumina and chromia) can reduce coke deposition by 50% or more.

Waste water purification

Waste water containing petroleum and other impurities can be purified by crystalline dolomite filter beds according to Tidewater Oil Co. in U. S. Patent 2,785,123. The water is passed downward through a series of beds, while air is bubbled upward to float impurities on the top of the filter bed.

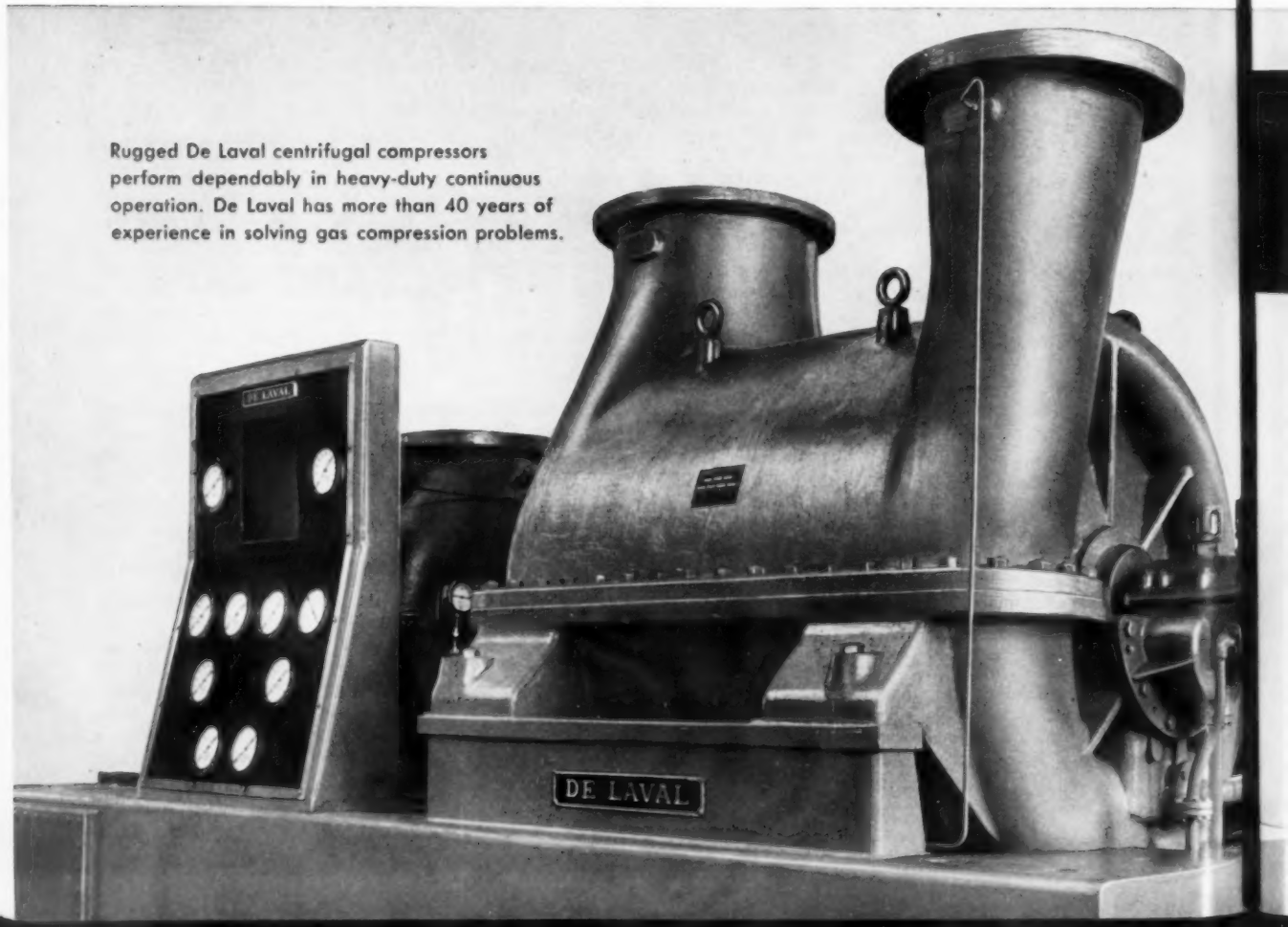
Turn page for Patent Listing

Patents (continued)

THE FOLLOWING PATENTS are selected from the Official Gazette of the U.S. Patent Office for Feb. 19, 26, Vol. 715, Nos. 3, 4; and March 5, 12, 19, Vol. 716, Nos. 1, 2, 3. Copies of patents are available for 25¢ each. Order by patent number from the Commissioner of Patents, Washington, D. C.

Processes and Methods

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Absorption	natural gas liquids	water-quench cycle	Phillips Petroleum Co.	2,784,806
Adsorption	H_2S from natural gas	cyclic system	Jefferson Lake Sulphur Co.	2,784,804
	gaseous feed mix	finely divided solid adsorbent	Esso Research & Engrg. Co.	2,782,866
Catalytic conversion	hydrocarbons	descending solid cat particles	Universal Oil Products Co.	2,785,110
Catalytic cracking	petroleum oil	silica-alumina cracking catalyst	Gulf Research & Development Co.	2,782,144
Catalytic reforming	hydrocarbons	alumina-chromium oxide catalyst	Standard Oil Co. (Ohio)	2,784,147
	hydrocarbons	alumina-MoO_3-fluorine cat.	Phillips Petroleum Co.	2,784,162
	naphtha	Fluid hydroforming system	Esso Research & Engrg. Co.	2,786,019
	naphtha	oxidative atmosphere	Standard Oil Co. (Ohio)	2,783,185
Chlorination	diisobutylene	reaction at 90-110°C	Sinclair Refining Co.	2,783,285
	diisobutylene	vapor-phase reaction	Sinclair Refining Co.	2,785,207
Collection	carbon black	centrifugal agglomerator	Phillips Petroleum Co.	2,785,964
Conversion	hydrocarbons	two separate fluid streams	Socony Mobil Oil Co., Inc.	2,783,186
	hydrocarbons	vanadium impregnated carriers	Union Oil Co. of Calif.	2,785,141
Determination	hydrocarbon mol %	gas tester for natural gas	Phillips Petroleum Co.	2,783,640
	metal corrosion rate	direct current apparatus	Pure Oil Co.	2,786,021
Etherification	hydroxyaromatics	hydroquinone-methanol reaction	Universal Oil Products Co.	2,782,239
Extraction	acidic sulfur impurities	aqueous caustic alkali solution	American Development Corp.	2,783,184
	lube contaminants	aliphatic hydrocarbon solvent	Esso Research & Engrg. Co.	2,785,194
Flash Separation	hydrocarbons	adsorbent system	Jefferson Lake Sulphur Co.	2,784,798
Fluidization	acid sludges	phenol & alkylated phenol mix.	Esso Research & Engrg. Co.	2,782,146
Fractionation	asphalt	use of n- & isopentane & hexane	Kerr-McGee Oil Industries, Inc.	2,783,188
Hydrocracking	residual oils	resid mixed with aromatics & paraffinic naphthas	Sun Oil Co.	2,782,145
Isomerization	hydrocarbons	immiscible isomerization cat.	Phillips Petroleum Co.	2,782,244
	xylenes	hydrogenation	California Research Corp.	2,784,241


Rugged De Laval centrifugal compressors perform dependably in heavy-duty continuous operation. De Laval has more than 40 years of experience in solving gas compression problems.
DE LAVAL
DE LAVAL

Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Liquefying	methane	compression & cooling	Constock Liquid Methane Corp.	2,783,624
Manufacture	acetylene	oxygen-gaseous hydrocarbon react.	Delhi-Taylor Oil Corp.	2,785,213
	carbon black	ceramic-lined furnace	Phillips Petroleum Co.	2,785,054
	carbon black	helically traveling hot combustion gas	Phillips Petroleum Co.	2,785,053
	carbon black	hydrocarbons in cylind. reactor	Columbian Carbon Co.	2,782,101
	catalysts	silica-alumina composition	Esso Research & Engrg. Co.	2,785,140
	durene	HF-BF_3 catalyst	Standard Oil Co. (Ind.)	2,784,242
	hard waxes	dewaxing and stripping	Sun Oil Co.	2,783,183
	hydrazine	anhyd. dihydrazine SO_4 ammonolysis	Olin Mathieson Chemical Corp.	2,783,130
	hydrogen	moving solids pyrolysis of hyrocarbon gas	Socony Mobil Oil Co., Inc.	2,783,133
	impregnated catalysts	porous catalyst carrier	Gulf Research & Development Co.	2,783,211
	ketenes	pyrolysis furnace	Eastman Kodak Co.	2,784,065
	lube oil	alkyl phenol sulfides	Esso Research & Engrg. Co.	2,785,131
	lube oils	dewaxing process	Phillips Petroleum Co.	2,786,015
	metal oxide cats.	low sulfate content	Esso Research & Engrg. Co.	2,786,037
	NH_4NO_3 prills	spraying into prilling zone	Phillips Petroleum Co.	2,782,108
	nitriles	S-NH_3-lower alkyl benzene react.	California Research Corp.	2,783,266
	organic thiols	aliph. alc.—H_2S reaction	Pure Oil Co.	2,786,079
	oxygen	decomposition of Cr_2O_3	Standard Oil Co. (Ohio)	2,783,134
	sulfur	H_2S and SO_2 containing gases	Metallgesellschaft AG	2,785,056
	noble metal cats.	Platinum, H_2, and Cl_2 vapor	Houdry Process Corp.	2,785,138
Oxidation	naphthalenes	phthalic anhydrode product	American Cyanamid Co.	2,783,249
	propylene	liquid phase reaction	Escambia Chemical Corp.	2,784,202
Plasticizer agent	polyhydroxy alc. ester	oxidized paraffin wax	Union Oil Co. of Calif.	2,783,270
Preparation	dry mixture	ammonium fluosilicate & silica	W. R. Grace & Co.	2,785,953
	polycyclic aromatic	polyoxyalkylene glycol solvent	Universal Oil Products Co.	2,786,085
Prevention	plugging	treat during alkali treat	Universal Oil Products Co.	2,786,017
Purification	alcohols	aq. soln. of bisulfite cmpd.	Stanolind Oil & Gas Co.	2,783,190
	gas	glycolic compounds	Universal Oil Products Co.	2,781,863
	phenol	extrac.-separ.-extrac.-recov.	B.A. - Shawinigan Ltd.	2,782,242
	toluic acids	decomp. or poly. of impurities	Richfield Oil Corp.	2,786,020
	toluic acids	dist., cryst. & washing	Richfield Oil Corp.	2,785,199
	waste water	dolomite filter beds & air	Tidewater Oil Co.	2,785,123

Continued on page 268

DE LAVAL
CENTRIFUGAL
COMPRESSOR

helps boost cat-cracker capacity at Shell Oil of Canada, Limited

To obtain extra capacity, the Montreal East refinery of the Shell Oil Company of Canada, Limited decided to rebuild its cat-cracker. Since the modernized cracking unit required a greater volume of air, Shell of Canada selected a dependable De Laval centrifugal compressor handling 16,400 cfm.

This compressor operates at an inlet pressure of 14.3 psia and a discharge pressure of 42.8 psia. The power required is 1860 bhp with the compressor operating at 5400 rpm.

The Shell Oil Company of Canada, Limited is another refinery which has chosen De Laval compressors for heavy-duty continuous service. Whether you need to handle light or heavy gases at high or low pressures in catalytic cracking, reforming, alkylation, coking or any similar service, it pays to look to De Laval.

Send for Bulletin 0504

DE LAVAL *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

900 Nottingham Way, Trenton 2, New Jersey

DL378

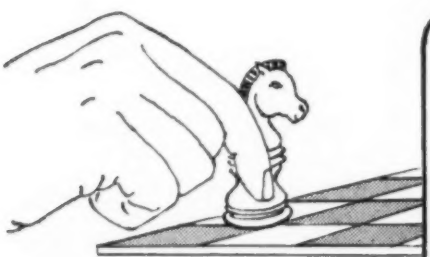
Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASIGNEE . . .	PATENT NO.
Purifying	moist chlorine gas	chlorine hydrate & ice formation	Gulf Oil Corp.	2,785,0[illegible]
Recovery	dewaxing aids	solid adsorbent	Phillips Petroleum Co.	2,782,1[illegible]
	metal halide cat.	solid absorbent	Phillips Petroleum Co.	2,786,0[illegible]
	methanol	subzero temperature stripping	Blaw-Knox Co.	2,781,8[illegible]
	phenol	crude desalt. during cat. conv.	Gulf Oil Corp.	2,785,1[illegible]
	pure n- & isobutane	fractionation process	Esso Research & Engrg. Co.	2,785,11[illegible]
Regeneration	dehydrator	moisture-free gas	National Petro-Chemicals Corp.	2,784,8[illegible]
	noble metal cats.	gas having H_2 and HCl	Houdry Process Corp.	2,785,13[illegible]
Removal	arsenic in gasoline	cumene hydroperoxide-glacial acetic acid	Universal Oil Products Co.	2,782,143
	nickel catalyst	admixture in hydrogenated polybutadiene	Phillips Petroleum Co.	2,786,047
Separation	alkyl benzenes	$HF\text{-}BF_3$	Standard Oil Co. (Ind.)	2,785,211
	carbon black	electrostatic agglomeration	Phillips Petroleum Co.	2,785,769
	CO_2 from NH_3	alkylolamine solvent	Chemical Construction Corp.	2,785,045
	wet hydrocarbon gases	pressure and absorption	Union Oil Co. of Calif.	2,782,141
Stabilization	cracked gasolines	H_2SO_4 promoted BF_3	Gulf Research & Development Co.	2,786,016,8
Sulfonation	petroleum oils	chlorinated hydrocarbon & SO_3	Sinclair Refining Co.	2,783,273
Testing	hydrogen oil conc.	electrodes & potential diff.	Petrolite Corp.	2,782,151
Withdrawal	granular solids	liquid-solids contactor	Socony Mobil Oil Co., Inc.	2,783,189

Products

Composition	film-forming oil	dibasic lead phosphite stabilizer	J. J. Taylor	2,783,160
	wax	1% nonaethylene glycol distearate	Moore & Munger	2,783,161
Cutting oil	mineral lube oil	sulfur & sulfochlorinated monoolefin polymer	The Texas Co.	2,786,031
Derivatives	ethylene-urea	method of manufacture	Olin-Mathieson Chemical Corp.	2,785,176
Dibasic acid esters	glycols	ether linkages	Esso Research & Engrg. Co.	Re 24,287
Extreme press. lube	mineral lube oil	lead soap, etc.	The Texas Co.	2,785,130
Grease composition	lube oil	alk. metal soap of satd. fatty acid	Esso Research & Engrg. Co.	2,782,166
	mineral lube oil	carboxylic acid soap	Shell Development Co.	2,782,165
Inhibition	corrosion	alkali metal salt of diisoamyl orthophosphoric acid	Gulf Oil Corp.	2,786,033
Lube composition	lube oil	viscosity index improvement	Esso Research & Engrg. Co.	2,782,167
	lube oil	anti-corrosion additive	Gulf Oil Corp.	2,786,028

Continued on page 270



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TAYLOR-WHARTON Gas Transports provide mobility of gas storage for users of bulk compressed gases. Economy and flexibility of operations make these transports preferable to permanent bulk storage for many oil refining, petrochemical, food and electronic companies, especially where interplant haulage and standby needs are important.

Each transport contains a group of seamless steel storage pressure tubes made to ICC-3A2400 specifications. Rigidly mounted to a standard semi-trailer chassis, the tubes are valved and manifolded together to a common outlet in a rear-mounted weatherproof cabinet. Standard capacities from 38,500 cu. ft. to 56,250 cu. ft. Other sizes as required.

Send for further information, mentioning type of gas and storage requirements

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Division of HARSCO CORPORATION

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TRECO—CONTRACTOR TO AMERICA'S FAMOUS REFINERS*

The REFINERY ENGINEERING Company is proud to have served the majority of America's best-known refiners in the field of Engineering, Design and Construction. Each year sees our list of satisfied clients expanding.

Back of this steady expansion is the satisfactory completion of each contract on, or ahead of time; the ease and economy of operation of the plant as well as the small amount of "down time."

Treco has purchased a tract of land, in excess of three acres. This new facility provides more than 14,000 square feet of air-conditioned offices with paved parking for over 200 cars. There is also a cafeteria building and two other buildings of 9,700 feet and 37,000 feet of space for expanding Treco activities.

* The Trade Marks above are of the companies Treco has recently served.

The REFINERY ENGINEERING Company has just produced a brochure which shows the Company's facilities with photographs of completed projects. A copy will be mailed you promptly upon request on your company's letterhead.

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The REFINERY ENGINEERING Company

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Patents (continued)

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT NO.
Lube Composition (Cont.)	lube oil	corrosion inhibitor	The Texas Co.	2,785,129
	mineral lube oil	acidic metal salt	Esso Research & Engrg. Co.	2,786,129
	mineral lube oil	detergent properties	Gulf Oil Corp.	2,786,130
	mineral lube oil	pour depressant & vis index improver	Esso Research & Engrg. Co.	2,786,132
	mineral oil	rust-preventive additive	Tidewater Oil Co.	2,783,106
Prevention	corrosion	S-P-containing hydrocarbon	Esso Research & Engrg. Co.	2,783,203-4
	rust	film-forming inhibitor	Esso Research & Engrg. Co.	2,783,156
Propellant	ammonium perchlorate	TNT, SAE 10 oil & asphalt	Aerojet-General Corp.	2,783,138
Protective lube	mineral lube oil	microcrystalline wax & air-blown asphalt	Sinclair Refining Co.	2,785,111
Suppression	acidic gas evolution	organic sulfur-containing mat'l	Socony Mobil Oil Co., Inc.	2,783,205

Equipment

Absorption	liquids	tower having special trays	Carter & Nansen Co., Inc.	2,785,961
Determination	refractive index diff.	two monochromatic radiation beams	Esso Research & Engrg. Co.	2,783,676
Exchange	heat	pebble heater	Phillips Petroleum Co.	2,784,066
Heat exchange	materials	improved pebble heat exchanger	Phillips Petroleum Co.	2,783,097
	vapor-solids	pebble exchanger chamber	Phillips Petroleum Co.	2,782,106
Heating	materials	pebble apparatus	Phillips Petroleum Co.	2,782,924
Indication	combustible gas	elect. conductive refractory	Phillips Petroleum Co.	2,782,103
Indication & control	solids level	handling of gran. moving solids	Union Oil Co. of Calif.	2,783,096
Manufacture	carbon black	safety system	Phillips Petroleum Co.	2,785,960
	hydrogen cyanide	NH_3-O_2-hydrocarbon react.	DuPont Co.	2,782,107
	unsat. hydrocarbons	regenerative furnace	Phillips Petroleum Co.	2,785,212
Pumping	volatile liquids	recovery of vapors	Independent Engrg. Co., Inc.	2,785,544
Separation	gas-liquids	internally baffled horiz. tank	Sivalls Tanks, Inc.	2,783,854
	gases-solids	separators in pneumatic lift	Socony Mobil Oil Co., Inc.	2,783,099
	mixtures	bubble cap riser assembly	C. F. Braun & Co.	2,785,882
	oil-water	use when cleaning oil tanks	Sun Oil Co.	2,782,929
	solids-liquids	cyclone having dipleg seal	Esso Research & Engrg. Co.	2,784,803
Solvent extraction	oil-bearing materials	solution draining means	International Basic Economy Corp.	2,782,928
Storing & shipping	liquefied gas	insulated carrier	Messer Corp.	2,784,560

THIS "VALVE WITH A THOUSAND SEATS" . . . increases PUMP EFFICIENCY and PUMP CAPACITY

● Here's a revolutionary idea in pump valves that results in much longer, trouble-free valve life and greater pump capacity. The ROYAL CROWN PUMP VALVE has only three separate parts. Valve is guided by a frictionless ball stem (not a rigid guide) which allows it to oscillate and turn with the fluid stream. It swings freely with each stroke of the pump — seating perfectly each time in a new position. There is a minimum of resistance to the fluid, which results in greater pump volume at less pump speed. Royal Crown PUMP VALVES handle all types of liquids . . . are adaptable to all reciprocating pumps.

Royal Crown PUMP VALVES

(A) Round valve surface is streamlined. No obstructions to restrict the flow. (B) Ball-guided valve rotates and swings with each stroke of the pump. Each turn, each swing . . . a lapping action, a continuing perfect seat. (C) Free vertical action assures instant opening and closing. Ball stem is a frictionless guide.

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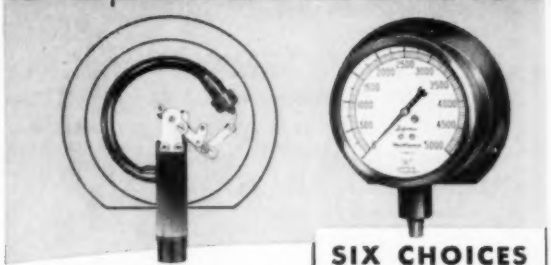

—from inlet to tip

Now the superlative Mastergauge is available in a wider range of corrosion resistant tubes and sockets than any other pressure gauge.

Check the adjoining list. And remember that tube socket and tip are fused into one piece by the exclusive Marsh "Conoweld" process.

Marsh alone combines the "Conoweld" construction, the copper-clad "Marshalloy" case, the finer Mastergauge movement, the Marsh "Recalibrator", the new "Safecase." Ask for data covering your specific needs.

SIX CHOICES of tubes and sockets

4130 alloy steel tube with alloy steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

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316 stainless steel tube with 303 stainless tip and socket.

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MARSH "THE STANDARD OF ACCURACY"

DU PONT *Petroleum Chemicals* NEWS

One of a Series of Bulletins for the Petroleum Industry

MAY 1957

NEW DIRECTOR OF SALES FOR PETROLEUM CHEMICALS

W. SAM CARPENTER, III, has been appointed to succeed David H. Conklin as director of sales of the Du Pont Petroleum Chemicals Division. Mr. Carpenter was promoted to this position from that of assistant director of sales.

Mr. Conklin has been named managing director of the Du Pont Company (United Kingdom) Limited. He plans to make his home in London next year.

Alfred R. Mullis, formerly Eastern regional manager of the Petroleum Chemicals Division, replaces Mr. Carpenter as assistant director of sales.

Mr. Carpenter came to the Petroleum Chemicals Division in 1955 from the Cellulosics Division of the Textile Fibers Department where he was director of manufacturing. Prior to joining Textile Fibers, he had been manager of the Du Pont Industrial Engineering Division. He joined the Du Pont Company in 1938 as an industrial engineer.

In 1944 and 1945, he was active in the construction and operation of the government's atomic energy project at Hanford, Washington. Mr. Carpenter received his chemical engineering degree from Princeton University.

Mr. Conklin, who came to Du Pont as a sales-service representative from Ingersoll-Rand, has been with the Petroleum Chemicals Division since it was organized. He was promoted to West Coast regional manager, then to sales pro-

OVER

Refiners can use these marketing services profitably

The Du Pont Petroleum Chemicals Division offers a wide range of marketing aids and services. Many of these are ideal for dealer meeting programs. Others can be profitably used in promotion campaigns. Here is a brief résumé of the Du Pont marketing services now available to you:

MOVIES available from Du Pont make ideal program material for your dealer meetings.

"When the customer says 'KNOCK'" is a Du Pont sponsored, full-color motion picture to instruct dealers on how to handle, in a salesmanlike way, customer complaints about gasoline quality.

This is but one of a series of films. They cover subjects ranging from gasoline quality, just mentioned, to an explanation of the benefits to the public of the percentage depletion allowance. Folders describing these films in detail, along with information on borrowing them, can be obtained from any of our sales offices.

Special demonstration equipment

To help refiners explain quality features of their products clearly and graphically, we have designed and built a number of special demonstration devices. The latest is a machine for showing how carburetor icing occurs and can be prevented with Du Pont dimethyl formamide.

I. T. Rosenlund is shown here operating the de-icing demonstration.

This equipment is ideal for pointing up convincingly your product-quality

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT *Petroleum Chemicals* NEWS

Du Pont equipment and experience usually available to refiners

REFINER:

Yes, we anticipated that fuel injection systems in cars would raise some new problems in gasoline blending . . .

DU PONT REPRESENTATIVE:

That's right, and our Petroleum Laboratory has already been making road tests using special fuels in injection systems.

REFINER:

Is that so – then maybe you people already have some data we could use?

DU PONT REPRESENTATIVE:

We're accumulating it gradually. We have three fuel-injection cars in our Petroleum Lab.

REFINER:

Good! I hope we can get the results of your investigations.

DU PONT REPRESENTATIVE:

I'll see that you do. As our road tests develop further facts we'll keep you informed.

CONTINUED *Marketing Services*

features to dealer and customer groups.

We can also supply you with a great variety of booklets and visual presentations on gasoline and motor oil quality, customer relations, station services, and other subjects. You can obtain these in large quantities at cost, or at no charge if you'd like only a few copies.

Continuing market surveys

When planning promotion campaigns, you can make use of the findings of our several extensive surveys of customer buying habits and service station operations.

These cover such subjects as the factors influencing a dealer's success, why motorists buy the brands they do, how they select service stations, and which factors in gasoline-brand advertising influence them most.

A report on our latest – and perhaps most important – survey will be finished by mid-summer. The results will be made available to all marketing executives in the oil industry.

Public relations aids

Our newest presentation emphasizes the importance, to everyone, of the petroleum industry – "A 'Brief' Case for Business." It is a lightweight kit which enables you to tell a forceful public relations story in a dramatic way. This kit was conceived and developed by Du Pont and is made available to oil companies through the Oil Information Committee of API, or through your Du Pont representative.

You can probably save time and

continued middle next column

H. C. Thompson displays the "Brief" case public relations kit.

money by supplementing your own promotion program with these useful aids, adapting them to your own purposes. Any of our Petroleum Chemicals Division representatives or sales offices will be glad to give you more information on them.

CONTINUED *New Director of Sales*

motion manager, later assistant director and then director of sales.

Conklin a Navy veteran

During World War II, Mr. Conklin as Commander U. S. Navy, was on active duty 5 years – most of the time in the North Atlantic. He was awarded the Order of the British Empire.

Mullis former sales representative

Alfred R. Mullis joined the Du Pont Company in 1947 as a sales representative in the Gulf Coast Region. He was appointed regional manager there in 1951. The following year he went to New York as Eastern regional manager.

After graduating from Rice Institute with a chemical engineering degree, Mr. Mullis was associated with the Humble Oil and Refining Company in research and development work. While an officer in the Navy from 1942 to 1946, he specialized in petroleum inspection work.

SALES OFFICES

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Cleveland 15–25 Prospect Ave. . . . SUperior 1-1363
Denver 2–510 Mile High Center Bldg. AComa 2-2347
Houston 2–
705 Bank of Commerce Bldg. . . . . CApitol 5-1151
Los Angeles 17–612 So. Flower St. MAdison 5-1691
New York 20–
1270 Ave. of the Americas . . . . COlumbus 5-2342
Philadelphia 2–3 Penn Center Plaza LOcust 8-3531
Pittsburgh 22–1 Gateway Center . ATlantic 1-2933
San Francisco 4–111 Sutter St. . . . EXbrook 2-6230
Seattle 3–4003 Aurora Ave. . . . . MElrose 6977
Tulsa 1–1811 So. Baltimore Ave. . . . LUther 5-5578
In Canada–Du Pont Company of Canada (1956) Limited, Petroleum Chemicals, 85 Eglinton Ave. East, **Toronto 12**–Ontario . . . . . HUdson 1-6461
In Other Countries–Petroleum Chemicals Division, Export Sales, 7496 Nemours Bldg., Wilmington 98, Del., OLympia 4-5121, Ext. 2962

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. . . through Chemistry

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

Printed In U. S. A.

Rocky Mountain refiners meet in June

A SESSION on reforming and desulfurization will be tied in with a visit to Carter Oil Co.'s desulfurizer, reformer and Fluid coker when the Rocky Mountain Oil and Gas Association's refining committee holds its annual meeting. The dates are June 18 and 19 and the site the Northern Hotel, Billings, Mont.

Speakers on the program of the reforming and desulfurizing session are:

W. H. Decker, Sinclair Oil Co., "Regenerative Reforming — Sinclair-Baker RD-150 Catalyst,"

Charles McMahan, Universal Oil Products Co., "Superior Quality and Gasoline From High Sulfur Feed Stocks by Unifining and Platforming."

T. M. Moore, Standard Oil Co. (Ind.), "Ultraforming—A Rugged, Flexible Process for Top Octanes."

After a recess, the oilmen will visit Carter's refinery by bus

A session on waste pollution will present Edmund C Garthe, U. S. Public Health Service, Denver, who will speak on "Pollution Problems in the Rocky Mountains as They Affect the Missouri Basin."

A panel discussion on waste disposal will follow.

The final day of the meeting will be occupied by a session on safety, industrial and public relations.

Data processing course scheduled for New York

Electronic Data Processing for Business and Industry, a course given by Canning, Sisson and Associates last fall, will be repeated twice in New York this spring and summer. The course emphasizes applications rather than details of equipment, and will take up such subjects as: patterns of data processing, making the systems study, procedural analysis, and planning the electronic system.

Sessions from May 20-24 will be held at the Park-Sheraton Hotel in New York. The sessions from July 22-26 will be at New York's Hotel Roosevelt. Full details may be obtained through the sponsors at 1140 S. Robertson Blvd., Los Angeles 35, Calif.

Engineer development is theme of NSPE annual

Professional development of the young engineer will be the focus of the National Society of Professional Engineers when it holds its annual meeting, June 5-8, in Dallas' Statler-Hilton Hotel.

The conference on young engineers in industry will have the following panel participants: Winston Oberg, employe relations department, Esso Research & Engineering Co., "Guiding the Young Engineer Toward His Greatest Potential"; T. M. Medland, Association of Professional Engineers of Ontario, "Solving the Problems of Young Engineers Through a Professional Approach"; Frank Hurley, manager, management education and college relations, American Cyanamid, "Professional Advancement on the Technical Ladder"; and Dr.

Oil Man's Calendar

Boldface items reviewed in this issue

MAY

16-18 NY State Society of Professional Engineers, annual, Statler, New York
20-23 Design Engineering Show, ASME, Coliseum, New York
20-24 National Fire Protection Assn, annual, Hotel Statler, Los Angeles
22-24 American Institute of Chemists, annual, Sheraton-Mayflower, Akron
22-24 American Society for Quality Control, annual, Masonic Temple, Detroit
26-28 Synthetic Organic Chemical Manufacturers Assn., outing, Skytop, Pa.

JUNE

2-7 Society of Automotive Engineers, summer meeting, Chalfonte-Haddon Hall, Atlantic City
3-5 Chemical Institute of Canada, annual, Vancouver, B.C.
5-8 National Society of Professional Engineers, annual, Statler-Hilton, Dallas
6 Pennsylvania Grade Crude Oil Assn., annual, Penn-Sheraton, Pittsburgh
2-12 American Institute of Chemical Engineers, national, Olympic Hotel, Seattle, Wash.
2-13 American Society of Mechanical Engineers, semiannual, Sheraton Palace Hotel, San Francisco
9-13 Automation Congress, Coliseum, New York City
10-14 Gordon Research Conference on Petroleum AAAS, Colby Junior College, New London, N.H.
11-13 Western Plant Maintenance and Engineering Show and Conference, Civic Auditorium, San Francisco
13-15 Division of Analytical Chemistry, American Chemical Society, summer symposium, Purdue U., Lafayette, Ind.
16-21 American Society for Testing Materials, annual, Chalfonte-Haddon Hall, Atlantic City
17-20 3rd Conference on Carbon, National Science Foundation, U. of Buffalo, Buffalo, N.Y.
17-21 Gordon Research Conference on Catalysis, AAAS, Colby Junior College, New London, N.H.
17-21 American Society for Engineering Education, annual, Cornell, Ithaca
18-19 Rocky Mountain Oil & Gas Assn., Refining Committee annual, Northern Hotel, Billings, Mont.
19-21 Assn. for Computing Machinery, annual, U. of Houston, Houston
24-28 American Institute of Electrical Engineers, summer general, Montreal
26-29 American Assn. of Cost Engineers, annual, U. of New Hampshire, Durham

JULY

8-12 Gordon Conference on Radiation Chemistry, New Hampton School, New Hampton, N.H.
15-19 Gordon Conference on Corrosion, Colby Junior College, New London
22-26 Electronic Data Processing for Business and Industry, Hotel Roosevelt, New York City

AUGUST

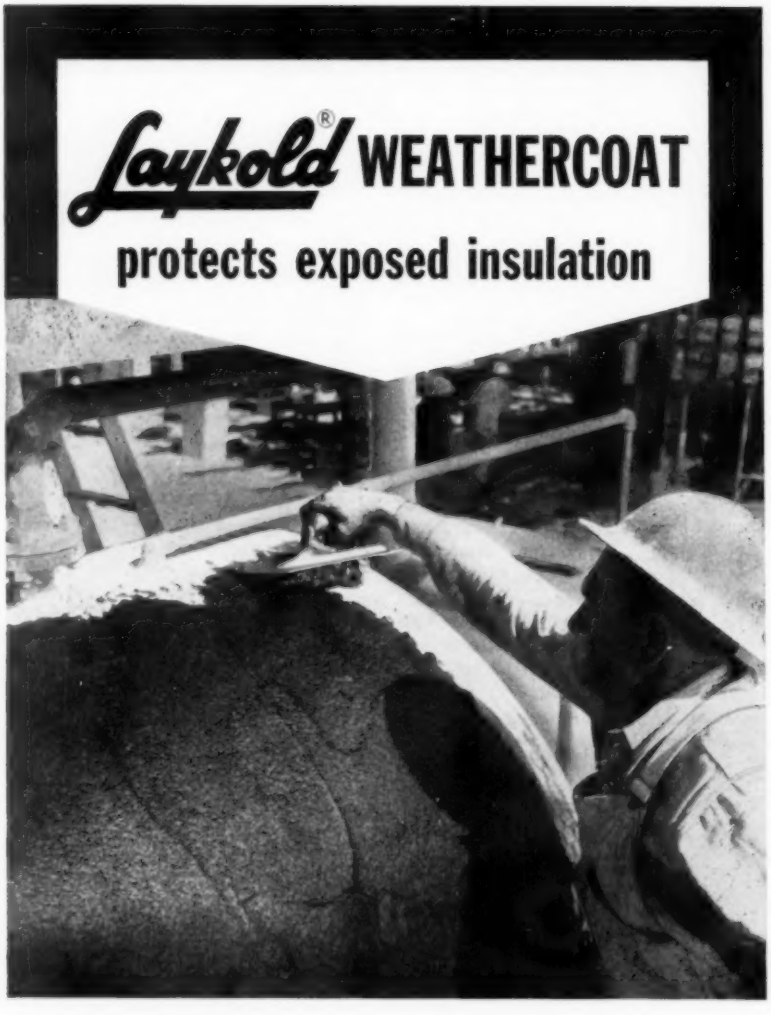
12-14 Society of Automotive Engineers, West Coast, Olympic Hotel, Seattle
26-30 American Institute of Electrical Engineers, Pacific General, Yakima, Wash.
28-30 Instrument Society of America, symposium on gas chromatography, Lansing, Mich.

SEPTEMBER

8-13 American Chemical Society, national, New York City
11-13 National Petroleum Assn., annual, Traymore Hotel, Atlantic City
22-25 Petroleum Mechanical Conference, ASME, Tulsa, Okla.
23-25 American Society of Mechanical Engineers, fall meeting, Statler, Hartford, Conn.

OCTOBER

7- 9 Lubrication Conference, ASME and the American Society of Lubrication Engineers, Royal York Hotel, Toronto
10-11 California Natural Gasoline Assn., annual, Huntington-Sheraton Hotel, Pasadena



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

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200 Bush St., San Francisco 20, California
Baltimore 3, Md. · Mobile, Ala. · Inglewood, Calif. · St. Louis 17, Mo. · San Juan 23, P.R. · Oakland 1, Calif. · Perth Amboy, N.J. · Cincinnati 38, Ohio · Tucson, Ariz. · Portland 7, Ore.

F. C. Peterson, director of industrial relations, Dow Chemical Co., "Evaluating the Young Engineer."

First annual meeting by cost engineers group

The first annual meeting of the American Association of Cost Engineers will be held at the University of New Hampshire, June 26-29. A symposium on operating costs is planned and the following papers will be read during the general session:

"Industry's Capital Spending Plans"

"Cost Indexes and Cost Trends"

"Depreciation Effects on Payout Time and Project Desirability Appraisal"

"Overhead Expense Distribution for Multiple Use Plants"

"Adapting Construction Cost Records to Property Records"

"Capital Estimating by Ratio Methods"

Maintenance Conference in San Francisco, June 11-12

Plant maintenance will for the third year receive the attention of experts at the Western Plant Maintenance and Engineering Show at San Francisco's Civic Auditorium, June 11 to 13.

One general session will be held on planning and scheduling maintenance work, with speakers representing plants employing fewer than 50 maintenance workers and more than 150. The other sessions will be concurrent, and a list of their titles follows:

"Preventive Maintenance—A Case Study"

"Upkeep of Buildings"

"A System of Maintenance Cost Control"

"Principles of Maintenance Storekeeping"

"An Effective Organization of Maintenance Manpower"

"Maintenance of Electrical Equipment"

"Pros and Cons of Area and Centralized Maintenance" (Among the speakers at this session is P. J. Gurklis, general superintendent, maintenance shops, Dow Chemical Co., Texas Division.)

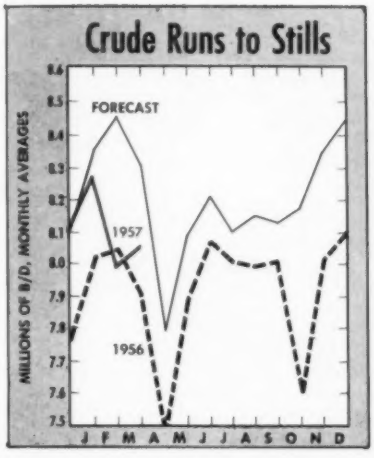
"Maintenance Training That Works"

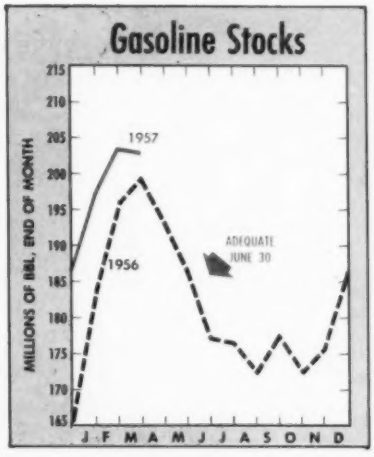
"How We Control New Projects"

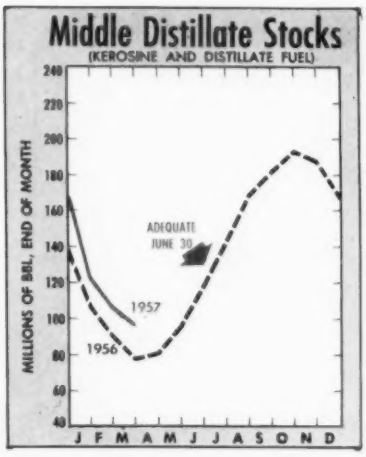
"Waste Disposal Problems and Their Solution"

"Getting Maintenance People to Work as a Team"

"Arriving at Work Standards"







The finger is on distillate stocks

THE RELATIVELY mild winter, plus the high rate of crude runs, have brought distillate fuel oil stocks in refiners' hands to the point where they may be burdensome this summer unless the rate of refinery operations is reduced.

OUTLOOK: For total product demand for the second quarter to run 3 to 3.5% larger than the second quarter of '56

Even with a total shipment of 20,600,000 bbl of this product to Western Europe from Nov. 1 through March, distillate fuel oil inventories April 12 for the U.S. were 74,156,000 bbl, nearly 22% higher than on April 13, 1956. Inventories of 60,832,000 bbl then were about 4% lower than the stocks of 63,360,000 bbl on April 15, 1955.

The shipments of distillate fuel from the Gulf Coast to Europe has also brought some shifting in the volume of stocks by refining districts. Combined inventories on the East and Gulf Coast districts April 12 were 48.4% of the U.S. total, while last year they were 49.1%. On the other hand, inland refining districts stocks April 12, were 39.9% of the U.S. total. A year ago on a comparable date they were 38.2% of the U.S. total. In volume, inland district inventories of 29,589,000 bbl April 12, were 27.4% larger than on April 13, 1956 (see table).

Refiners' gasoline stocks, on the other hand, 202,904,000 bbl April 12, were only 4% higher than on April 13, 1956, which is a little less than the gain in gasoline demand over 1956 for the first months of the year. In the Ind.-Ill.-Ky. district, the volume of current inventories is less than 1% larger than a year ago. The allocation of gasoline stocks by refining districts is about in line with a year ago.

The indicated gasoline demand for April for the U.S. is 4,100,000 b/d avg. The forecast of the Bureau of Mines for May is 4,200,000 b/d avg. Continued high crude runs are indicated, close to 8,000,000 b/d avg.

MARCH KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl at end of month)

	Mar. 1957	Feb. 1957	Mar. 1956
CRUDE OIL			
U. S. Production	7.782	7.512	7.278
Imports	.819	.819	.934
U. S. Stocks	252.311	253.094	265.683
Runs to Stills	8.050	7.996	7.914
GASOLINE			
Refinery Output	3.709	3.792	3.734
Refinery Demand	3.838	3.625	3.738
Primary Stocks	203.361	203.804	199.698
MIDDLE DISTILLATES			
Refinery Output	2.191	2.391	2.150
Refinery Demand	2.570	3.052	2.568
Primary Stocks	95.739	107.499	78.061
RESIDUALS			
Refinery Output	1.226	1.243	1.213
Imports & Other	.621	.642	.455
Total Supply	1.847	1.885	1.668
Refinery Demand	1.835	1.939	1.754
Primary Stocks	37.240	36.883	32.984

PRODUCT AND CRUDE PRICES

(Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$/bbl, principal fields
Source—Platt's Oilgram Price Service)

	Mar. 1957	Feb. 1957	Mar. 1956
Gasoline (regular)	12.68	12.68	11.63
Distillate Fuel Oil	10.40	10.50	9.53
Kerosine	11.92	12.01	11.02
Residuals	6.48	6.51	5.18
Above 4 Products	10.44	10.47	9.35
Lube Oils	24.17	24.17	22.27
Crude	3.18	3.18	2.84

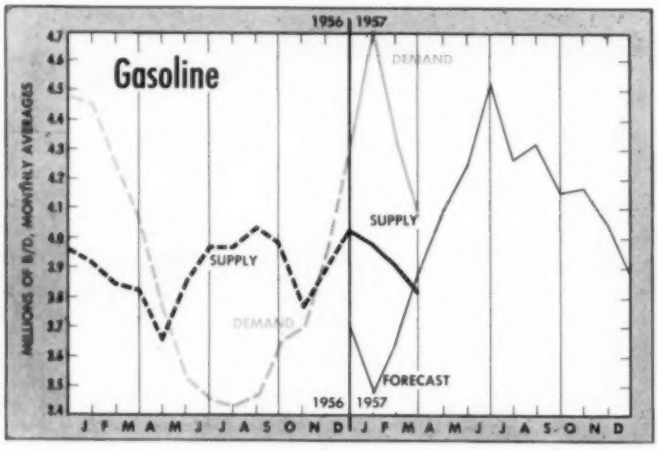
REFINERY YIELDS

% on Crude Runs to Stills

	Mar. 1957	Feb. 1957	Mar. 1956
Gasoline	42.0	43.2	43.2
Kerosine	4.1	4.5	4.3
Distillate	23.1	25.4	22.9
Residuals	15.2	15.6	15.4

SOURCE of DATA (except prices): Feb. and Mar., API weekly reports; earlier months Bureau of Mines

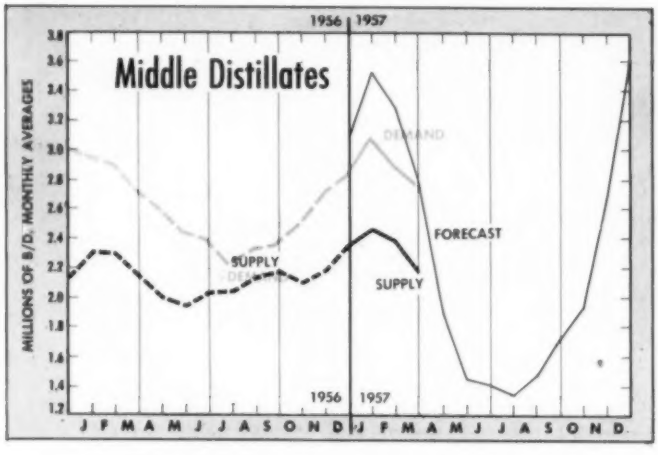
Gasoline demand in normal seasonal upswing



MOTOR FUEL

	From Crude		From Nat. Gas		Total
SUPPLY (Millions of b/d)					
Mar. '57	3.380		.444		3.824
Mar. '56	3.404		.425		3.829
Change	— 0.24	+	.019	—	0.05
% Change	— 0.7	+	4.5	—	0.1
DEMAND (Including Exports) (Millions of b/d)					
Mar. '57					3.838
Mar. '56					3.738
Change				+	.100
% Change				+	2.7
TOTAL SUPPLY (Millions of bbl)					
3 Mos. '57	310.848		40.802		351.650
3 Mos. '56	312.871		39.315		352.186
Change	— 2.023	+	1.487	—	.536
% Change	— 0.6	+	3.8	—	0.1
TOTAL DEMAND (Including Exports) (Millions of bbl)					
3 Mos. '57					333.781
3 Mos. '56					319.049
% Change				+	4.6

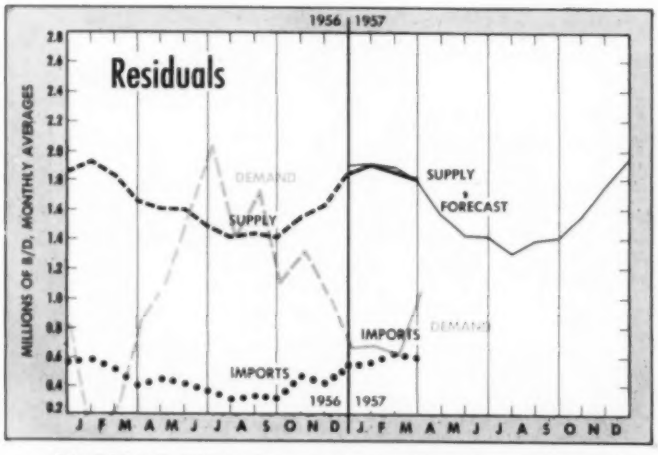
Mild late winter cuts distillate shipments sharply


Middle Distillates
1956 | 1957
MILLIONS OF B/D, MONTHLY AVERAGES
DEMAND
FORECAST
SUPPLY
SUPPLY
1956
1957
J F M A M J J A S O N D J F M A M J J A S O N D

MIDDLE DISTILLATES

	Kerosine		Dist. Fuel Oil		Total
PRODUCTION (Millions of b/d)					
Mar. '57	.328		1.863		2.191
Mar. '56	.342		1.808		2.150
Change	— .014	+	.055	+	.041
% Change	— 4.1	+	3.0	+	1.9
DEMAND (Including Exports) (Millions of b/d)					
Mar. '57	.375		2.195		2.570
Mar. 56	.395		2.173		2.568
Change	— .020	+	.022	+	.002
% Change	— 5.1	+	1.0		—
TOTAL PRODUCTION (Millions of bbl)					
3 Mos. '57	31.632		180.283		211.915
3 Mos. '56	33.695		171.284		204.979
Change	— 2.063	+	8.999	+	6.936
% Change	— 6.1	+	5.3	+	3.4
TOTAL DEMAND (Including Exports) (Millions of bbl)					
3 Mos. '57	43.968		239.997		283.965
3 Mos. '56	43.815		223.834		267.649
Change	+ .153	+	16.163	+	16.316
% Change	+ 0.3	+	7.2	+	6.1

Residual fuel imports up to 600,000 bbl daily



RESIDUAL FUELS

	Refinery Output		Imports & Other		Total
SUPPLY (Millions of b/d)					
Mar. '57	1.226		.621		1.847
Mar. '56	1.213		.455		1.668
Change	+ .013	+	.166	+	.179
% Change	+ 1.1	+	36.5	+	10.7
DEMAND (Including Exports) (Millions of b/d)					
Mar. '57					1.835
Mar. '56					1.754
Change				+	.081
% Change				+	4.6
TOTAL SUPPLY (Millions of bbl)					
3 Mos. '57	113.721		55.310		169.031
3 Mos. '56	116.583		49.022		165.605
Change	— 2.862	+	6.288	+	3.426
% Change	2.5	+	12.8	+	2.1
TOTAL DEMAND (Including Exports) (Millions of bbl)					
3 Mos. '57					176.338
3 Mos. '56					171.795
Change				+	4.543
% Change				+	2.6

SOURCE OF DATA: Feb. and Mar., API weekly reports; earlier months, Bureau of Mines (1956 figures for 366 days)

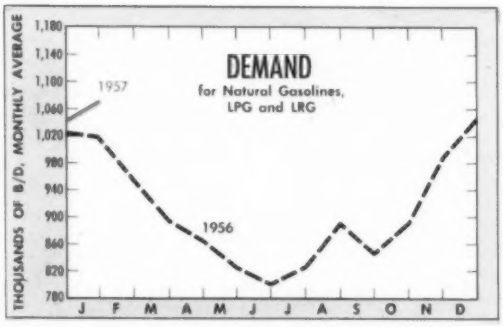
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change	GASOLINE STOCKS (Millions of bbl on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change	RESIDUAL STOCKS (Millions of bbl on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change
East Coast	1.226	1.046	+ .180	+17.2	43.433	40.158	+ 3.275	+ 8.2	8.248	7.975	+ .273	+ 3.4
Gulf Coast	2.595	2.737	— .142	— 5.2	37.545	38.261	— .716	— 1.9	6.106	6.243	— .137	— 2.2
Total Coastal	3.821	3.783	+ .038	+ 1.0	80.978	78.419	+ 2.559	+ 3.3	14.354	14.218	+ .136	+ 1.0
Appalachian	.203	.194	+ .009	+ 4.6	8.188	7.799	+ .389	+ 5.0	.733	.616	+ .117	+19.0
Ind.-Ill.-Ky.	1.389	1.336	+ .053	+ 4.0	41.259	41.061	+ .198	+ 0.5	4.930	3.712	+ 1.218	+32.8
Okla.-Kans.-Mo.	.735	.648	+ .087	+13.4	24.525	22.569	+ 1.956	+ 8.7	1.031	1.030	+ .001	—
Other Inland	.577	.513	+ .064	+12.5	21.473	19.821	+ 1.652	+ 8.3	3.055	2.338	+ .717	+30.7
Total Inland	2.904	2.691	+ .213	+ 7.9	95.445	91.250	+ 4.195	+ 4.6	9.749	7.696	+ 2.053	+26.7
Total East of Calif.	6.725	6.474	+ .251	+ 3.9	176.423	169.669	+ 6.754	+ 4.0	24.103	21.914	+ 2.189	+10.0
Calif.	1.174	1.077	+ .097	+ 9.0	26.481	25.390	+ 1.091	+ 4.3	12.655	10.874	+ 1.781	+16.4
Total U. S.	7.899	7.551	+ .348	+ 4.6	202.904	195.059	+ 7.845	+ 4.0	36.758	32.788	+ 3.970	+12.1

District	DISTILLATE FUEL OIL STOCKS (Millions of bbl on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change	KEROSINE STOCKS (Millions of bbl on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbl on date shown) Apr. 12 1957	Apr. 13 1956	Change	% Change
East Coast	22.612	17.697	+ 4.915	+27.8	8.097	6.813	+ 1.284	+18.8	30.709	24.510	+ 6.199	+25.3
Gulf Coast	13.311	12.148	+ 1.163	+ 9.6	4.596	4.626	— .030	— 0.6	17.907	16.774	+ 1.133	+ 6.8
Total Coastal	35.923	29.845	+ 6.078	+20.4	12.693	11.439	+ 1.254	+11.0	48.616	41.284	+ 7.332	+17.8
Appalachian	2.402	1.801	+ .601	+33.4	.842	.806	+ .036	+ 4.5	3.244	2.607	+ .637	+24.4
Ind.-Ill.-Ky.	12.997	10.279	+ 2.718	+26.4	3.584	3.248	+ .336	+10.3	16.581	13.527	+ 3.054	+22.6
Okla.-Kans.-Mo.	8.735	6.629	+ 2.106	+31.8	1.069	.778	+ .291	+37.4	9.804	7.407	+ 2.397	+32.4
Other Inland	5.455	4.525	+ .930	+20.6	1.321	1.000	+ .321	+32.1	6.776	5.525	+ 1.251	+22.6
Total Inland	29.589	23.234	+ 6.355	+27.4	6.816	5.832	+ .984	+16.9	36.405	29.066	+ 7.339	+25.2
Total East of Calif.	65.512	53.079	+12.433	+23.4	19.509	17.271	+ 2.238	+13.0	85.021	70.350	+14.671	+20.9
Calif.	8.644	7.753	+ .891	+11.5	.314	.336	— .022	— 6.5	8.958	8.089	+ .869	+10.7
Total U. S.	74.156	60.832	+13.324	+21.9	19.823	17.607	+ 2.216	+12.6	93.979	78.439	+15.540	+19.8

Natural gas and refinery gas liquids

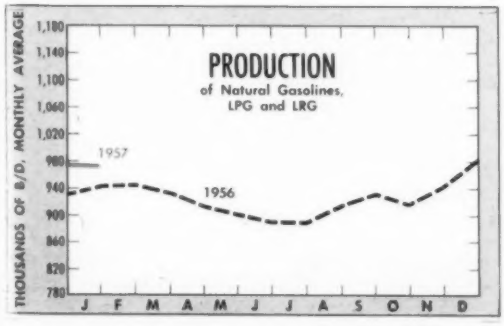


SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	Jan. 1957	Dec. 1956	Jan. 1956
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	459	463	432
Natural Gasoline and Isopentane	274	278	277
Condensate	23	19	24
Finished Gasoline, Naphtha and other	70	72	69
Total Natural Gasoline and Cycling Plant Production	826	832	802
Liquefied Refinery Gases	155	151	145
Total Marketable Gas Liquids	981	983	947
Lease Condensate	147	141	126
Total Natural Gas Liquids	1,128	1,124	1,073

CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	721	675	663
Natural Gasoline, Isopentane and other	355	374	357
Total Marketable Gas Liquids	1,076	1,049	1,020



CUMULATIVE PRODUCTION (1000 bbl)	Jan. 1957	Jan. 1956
LPG and LRG	19,017	17,911
Natural Gasoline, Isopentane and Other	11,318	11,459
Total Marketable Gas Liquids	30,401	29,370

CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	22,351	20,578
Natural Gasoline, Isopentane and Other	11,016	11,055
Total Marketable Gas Liquids	33,367	31,633

STOCKS (1000 bbl, end of month)	Jan. 1957	Dec. 1956	Jan. 1956
LPG and LRG	11,415	14,748	5,071
Natural Gasoline, Isopentane and Other	5,337	5,106	4,888
Total Stocks	16,752	19,854	9,959

INFORMATION OFFERED

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

Adsorption materials, fuller's earth, technical data; Floridin Co. See adv't. p. 289.

Aluminum, for heat transfer equipment, booklet; Aluminum Co. of America. See adv't. p. 295.

Aluminum coatings, for process equipment, brochure; Arthur Tickle Engineering Works, Inc. See adv't. p. 22.

Analyzers, gas, for process streams, literature; Mine Safety Appliances Co. See adv't. pp. 210-211.

Antioxidants, gasoline, lube oil, specifications, samples; Davison Chemical Co. Div W. R. Grace & Co. See adv't. p. 59.

Barium chemicals, detergent lube oil additive, booklet; Westvaco Mineral Products Div. See adv't. p. 166.

Burners, gas, oil, bulletin 111; Thermal Research & Engineering Corp. See adv't. p. 50.

Burners, vertical, gas and oil fired, bulletin DA-357; John Zink Co. See adv't. p. 302.

Catalysts, many types and shapes, booklet; Harshaw Chemical Co. See adv't. p. 1.

Cleaning compounds, for towers and vessels, booklet; Oakite Products, Inc. See adv't. p. 290.

Compressors, centrifugal, for gases, bulletin 0504; De Laval Steam Turbine Co. See adv't. pp. 266-267.

Compressors, turbocharged, bulletin ST-82; Cooper-Bessemer Corp. See adv't. p. 51.

Cooling towers, brochure; G. W. Galloway Co. See adv't. pp. 71-72.

Dryers, for air, bulletin D-100; C. M. Kemp Mfg. Co. See adv't p. 309.

Expansion joints and bellows, catalog; Solar Aircraft Corp. See adv't. p. 196.

Filters, heavy duty, bulletin; Sparkler Mfg. Co. See adv't p. 183.

Filters, for petroleum liquids, technical data; Commercial Filters Corp. See adv't. p. 279.

Flanges, pipe, forged steel, booklet; Phoenix Mfg. Co. See adv't. p. 200.

Flow metering elements, bulletin PP-5; Potter Aeronautical Corp. See adv't. p. 54.

Fluid controls, traps, brochure; Clark Mfg. Co. See adv't p. 312.

Fluid flow through packed static beds, booklet; Minerals & Chemicals Corp. of America. See adv't. p. 70.

Fluid processing equipment, dryers, separators, filters, specific bulletins; Selas Corp. of America. See adv't. p. 41.

Gages, stainless steel, data; Jas. P. Marsh Corp. See adv't. p. 270.

Gasket cutters, descriptive circular; Zimmerman Packing Co. See adv't. p. 174.

Gaskets, metallic, catalog; Metallo Gasket Co. See adv't. p. 45.

Heat exchangers, evaporative cooling type, bulletins 120 and 124; Niagara Blower Co. See adv't. p. 308.

Heat processing equipment, furnaces and heaters, specific bulletins available; Selas Corp. of America. See adv't. p. 40.

Heat transfer equipment, reactors, bulletin; Henry Vogt Machine Co. See adv't. p. 160.

Insulation, pipe, booklet; Union Asbestos & Rubber Co. See adv't. p. 307.

Insulation protection, asphalt base, brochure; American Bitumuls & Asphalt Co. See adv't. p. 274.

Insulation protection, colored coating, information; Insul-Mastic Corp. of America. See adv't. p. 161.

Materials handling, side loading fork lift truck, bulletin 1360; Baker-Raulang Co. See adv't. p. 60.

Mist eliminators, prevent liquid carryover, bulletin ME-6; Metal Textile Corp. See adv't. p. 177.

Mixers, side and top entering, 8 catalogs and data sheets; Mixing Equipment Co., Inc. See adv't. p. 58.

Motor starters, high voltage, bulleti 8130-F; Electric Controller & Mfg Co., Square D Co. See adv't. p 164.

Packing, asbestos, for pumps, valve catalog; Allpax Co., Inc. See adv't p. 247.

Packing, carbon graphite, for com pressors, literature; C. Lee Cook Co. See adv't. p. 65.

Packing, plastic, for pumps and valves bulletin P-325; Crane Packing Co See adv't. p. 304.

Pipe, plastic lined steel, information Dow Chemical Co. See adv't. p. 46

Pressure vessels and internals, literature; Fritz W. Glitsch & Sons, Inc See adv't p. 73.

Process control, electronic, literature; Manning, Maxwell & Moore, Inc See adv't. pp. 30-31.

Process equipment, vessels, fabrication, booklet; Newport News Shipbuilding & Dry Dock Co. See adv't p. 195.

Process equipment, fabrication, booklet; Chicago Steel Tank Co. See adv't. p. 248.

Public relations, movies for local television; Oil Information Committee. See adv't. p. 43.

Pumps, centrifugal, technical data; Dean Brothers Pumps, Inc. See adv't. p. 68.

Pumps, five designs, specific bulletins; Peerless Pump Div. See adv't. p 213.

Rotameters, for higher pressures, bulletin 360; Brooks Rotameter Co. See adv't. p. 296.

Seals, floating roof, bulletin TS; Hammond Iron Works. See adv't. p. 156.

Seals, for trays, knitted wire and asbestos, booklet; Metal Textile Corp. See adv't. p. 179.

Solvent extraction, with furfural, bulletin 203-A; Quaker Oats Co. See adv't. p. 26.

Sorptive processing, adsorbents, booklet, samples; Minerals & Chemicals Corp. of America. See adv't. p. 70.

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Tank vents, flame arrestors, catalog 76-16; Black, Sivalls & Bryson, Inc. See adv't. p. 176.

Telemetering equipment, pulse code receivers, bulletin CP-3011; Vapor Recovery Systems Co. See adv't. p. 292.

Thermocouple wire, insulated, bulletin 1200-1; Claud S. Gordon Co. See adv't. p. 174.

Thermometers, dial, mercury actuated, bulletin 350; Palmer Thermometers, Inc. See adv't. p. 262.

Tower packing, Pall Rings, bulletin TP-54; U. S. Stoneware Co. See adv't. p. 301.

Transmitter, instrument, electrical input, pneumatic output, catalog 98262; Taylor Instrument Cos. See adv't. p. 244.

Treating, chemical, electrofining, bulletin; Petreco Div. Petrolite Corp. See adv't. pp. 169-170.

Tube maintenance tools, cutters, cleaners, expanders, air operated, bulletin 59; Airetool Mfg. Co. See adv't. p. 286.

Tubes, heat exchanger, booklets; Wolverine Tube, Div. Calumet & Hecla, Inc. See adv't. pp. 193-194.

Tubes, reformer furnace, cast, bulletin T-283; Electro-Alloys Div. American Brake Shoe Co. See adv't. p. 291.

Valves, control, for high pressures and small flow, bulletin 9400; Annin Co. See adv't. p. 27.

Valves, control, bulletin CV53; Kieley & Mueller, Inc. See adv't p. 182.

Valves, diaphram, circular AD-1942; Crane Co. See adv't. p. 238.

Valves, for gases and liquids, bulletin CP6; Okadee Co. See adv't. p. 21.

Valves, sliding gate, motor diaphram, bulletin J-170; Jordan Corp. See adv't. p. 260.

Valves, stainless steel, technical data; Cooper Alloy Corp. See adv't. p. 242.

Valves, plug, spring loaded, jacketed, bulletin J-57; Hetherington & Berner, Inc. See adv't. p. 296.

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PDS 16,	**Chemico Nitric Acid**	Reprint **R41**
PDS 17,	**H_2SO_4 Alkylation**	Reprint **R44**
PDS 18,	**Process Reference List—1954**	Reprint **R48**
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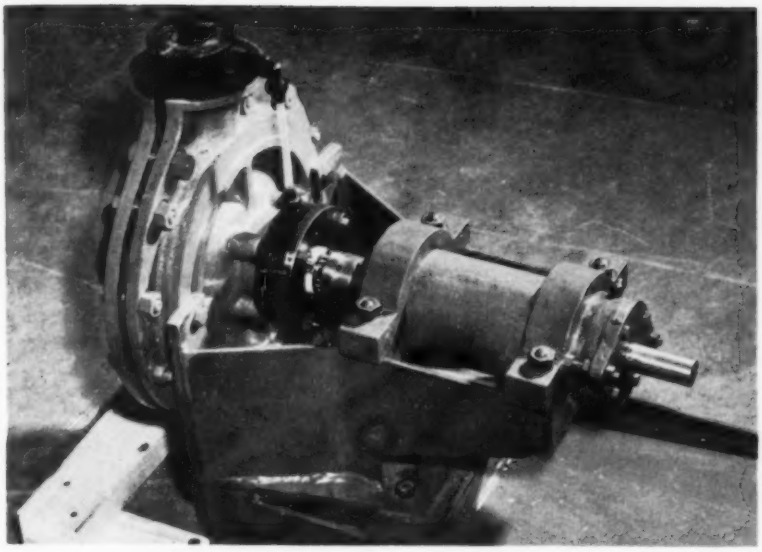


Lined pump handles corrosives

Because of the wide acceptance of saran-lined pipe, these new pumps lined with the same material now permit a complete corrosion resistant pumping system. Available in two sizes—1½ x 1-in. and 3 x 2-in.—these pumps are lined completely with saran and come equipped with mechanical-type seals.

These special seals are designed to eliminate the high frictional heat failures and leaks of packing glands used in corrosive service. Cooling of the seals is with the pumped fluid or external water. **Saran Lined Pipe Co.,** 2415 Burdette Ave., Ferndale 20, Mich.

Circle No. 1 on Reply Card

Sprinkler heads

. . . discharge both airfoam and water spray for quenching fires. Both upright and pendent sprinkler heads are available, and the pendent head permits adapting existing water sprinkler systems to the combination airfoam-water system.

A predetermined quantity of foam-producing material is automatically introduced into the water system. Using a foam blanket followed by a water spray is more economical than a continuous foam discharge. The following water spray also provides additional protection to surrounding surfaces from "torch" fires at broken chemical or fuel lines.

The water spray that follows the foam blanket does not diminish the effectiveness of the fire-smothering foam for approximately one-half hour under the water deluge. Manual controls on the combination system permit changing to a water spray at any time during foam discharge, or laying a blanket of foam without the shower of water. **Automatic Sprinkler Corp. of America,** Youngstown 1, Ohio.

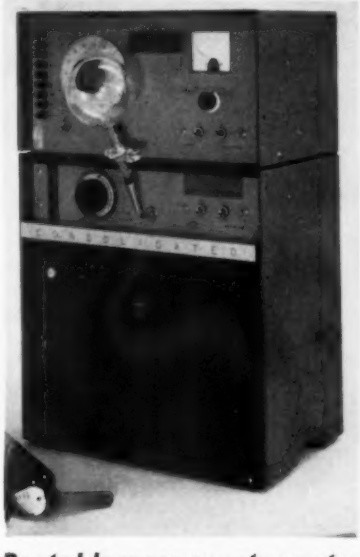
Circle No. 2 on Reply Card

Plastic tank lining

. . . is the first of a new plastic family. Saraloy 898 is an elastomeric copolymer based on vinylidene chloride, which has good resistance to a broad range of acids, alkalis, salt solutions and solvents.

The thermoplastic material is available in 37 x 133-in. sheets, in thickness from 1/16 to 3/16-in. thick. It can be applied in the field or in the shop to storage tanks, processing tanks, large pipes or ducts and hoods. There is no need for vulcanization after application, and the material will not support combustion. **Dow Chemical Co.,** Midland, Michigan.

Circle No. 3 on Reply Card



Portable mass spectrometer

. . . detects gas impurities in the low ppm range, and has good reproducibility. The Type 21-611 mass spectrometer is designed for both laboratory and industrial use.

Mass numbers appear linearly with time on a large motor-driven dial, making mass marking unnecessary. In a conventional instrument, peaks are recorded far apart in the low mass range and close together at the high end. In the 21-611, mass numbers appear equally spaced on a fixed time base. A manual override on the motor drive permits turning quickly to any mass number of interest, or to start and stop the automatic scan at any desired point.

The new instrument weighs only 115 lb. **Consolidated Electrodynamics Corp.,** 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle No. 4 on Reply Card

Turn page for more What's New

TV control center

For remote control of industrial TV

A TV control system that operates over a single coaxial cable permits tying in many TV cameras and receivers scattered over a wide plant area.

This system accommodates cameras of different manufacture in the same system, and allows them to be plugged in at any point in this closed-circuit. It also offers an unlimited number of outputs to commercially available television receivers in addition to the multiple input points. Cameras at different locations can be selected for showing, as well as adjusted for different subjects. No matter where the camera is plugged into the system, it can be controlled by the user from the point that is most convenient for him. **Jerrold Electronics Corp.,** 23rd & Chestnut Sts., Philadelphia 3, Pa.

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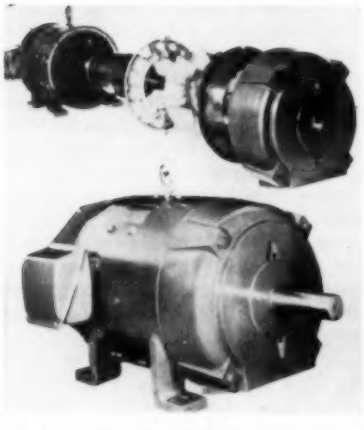


D-C motors and generators

. . . use high temperature silicone insulation to operate within Class B temperatures. Accelerated life tests indicate that this insulation will last 10 times that for ordinary Class B insulation, under any conditions.

Other features of this new line of motors and generators include a ventilation system that draws air from the drive end and distributes it through the machine and expels it at the commutator end; dripproof enclosures; and reduced armature inertia, by as much as 55 per cent. Motor ratings vary from 1 to 150 hp and generators are rated from ¾ to 100 kw. **Westinghouse Electric Corp.,** Box 2278, Pittsburgh, Pa.

Circle No. 6 on Reply Card

Acid-resistant pipe

. . . and tubing is now available in special stainless steels with extremely high resistance to many acids. Alloy B is a nickel-molybdenum-iron alloy with high resistance to hydrochloric acid in all concentrations and temperature. It also resists boiling sulfuric acid, phosphoric and wet hydrogen chloride gas. It is effective, however, only under non-oxidizing conditions.

Alloy C is a nickel-molybdenum-chromium-iron alloy with good resistance to aqueous solutions of halogen salts, nitric acid, and acids of ferric and cupric salts. It can also be used for acetic, formic, sulphurous, hydrochloric and phosphoric acids.

All the finished tubing from these two stainless steels is available to meet the requirements for heat exchanger applications, with sizes ranging from ⅝ to 4½-in. O.D. in tubing and ¼ to 4-in. in pipe. **Carpenter Steel Co.,** Alloy Tube Division, Union, N. J.

Circle No. 7 on Reply Card

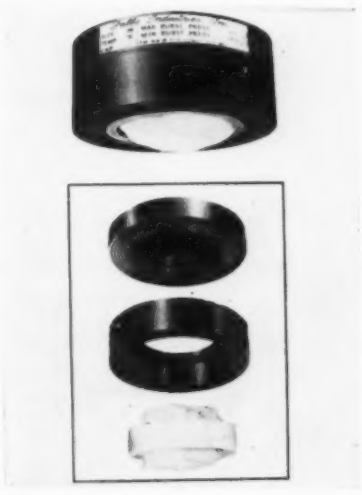
All-metal actuator

. . . for control valves, designed for both pneumatic and hydraulic control systems, is for difficult operating conditions such as atomic radiation, high temperatures and corrosion.

For use in highly corrosive atmospheres, the model is manufacured with stainless steel bellows and stem. The frame is cold rolled steel with a cadmium plate. It is available in three ranges of signal pressure: 3-15 psi, 6-30 psi, and 9-45 psi. It is com-

pact in size and has a maximum thrust of 3,000 lb. **Robertshaw-Fulton Controls Co.,** Box 400, Knoxville 1, Tenn.

Circle No. 8 on Reply Card



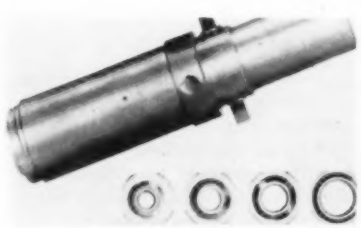
Rupture disc

. . . of impervious graphite withstands operating temperatures up to 650°F, much above previously high rupture disc limits of 340°F.

The Impervite disc uses a special insulating-spacer ring to hold a heat insulating material on the vessel side of the pressure membrane of the disc. However, this does not affect the disc's bursting characteristics according to the manufacturer.

These rupture discs are accurate to ±5% of the rated bursting pressure, are unaffected by practically all corrosives, and provide almost 100% clean rupture. Sizes available are in standard diameters from 2 to 12-in. for pressures from full vacuum to 100 psi. Special discs can be made up to 24-in diameter for 250 psi. **Falls Industries, Inc.,** Aurora Road, Solon, Ohio.

Circle No. 9 on Reply Card



Pipe nipple chuck

. . cuts nipples to any length on all threaders that are adjustable to 2 in. A movable sleeve guide has no "dead

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Hydrogen Processing—An Appraisal of Its Use in the Refinery, by Robert L. Davidson; what it is, how it works, what it does, who's using or planning to use it, processes and catalysts, 24 pages, December 1956 . . . . . Reprint **R34** $0.75

Optimum Bubble-Cap Tray Design, by William L. Bolles; presents new concepts and easy-to-use working charts for the process design of bubble-cap trays. 51 pages, 4-part series in February, March, April and May 1956 . . . . . Reprint **R15** $1.50

Chemical Treating of Petroleum Fuels, 4-article symposium on the chemical treatment of petroleum streams from crude through gasolines to convert and/or remove impurities. 24 pages, May 1956 . . . . . Reprint **R12** $0.75

Catalytic Reforming—And Aromatics Recovery in the Refinery, by Virgil B. Guthrie and Robert L. Davidson; what it is and does, who's using or planning to use it, processes for reforming and aromatics recovery. 48 pages, August 1955 . . . . . Reprint **R3** $0.75

Evaporation Losses—And their Control in Storage, by Willis A. Bussard; What evaporation is, storage conditions that affect it, equipment and other methods to reduce losses, estimating losses, selecting the right tank. 24 pages, July 1956 . . . . . Reprint **R2** $0.75

Vaporization Equilibrium Constant and Activity Coefficient Charts, by K. A. Smith and R. B. Smith; for use in described conditions ranging up to the critical point of the system. 48 pages, December 1949 . . . . . Reprint **R1** $1.50

PETROLEUM PROCESSING Data Sheets:

Process Data Sheets are process description with flow diagrams, process conditions, economics, etc, 3-page fold-out sheets—$0.20 each, or any 6 PDS or EDS sheets for $1.00:

PDS 1, **Ethylene Oxide**	R4	PDS 10, **Ammonia—Kellogg**	R26
PDS 2, **Butadiene • Butenes**	R5	PDS 11, **Pentafining**	R28
PDS 3, **L'Azote Ammonia**	R6	PDS 12, **Process Reference—1955**	R32
PDS 4, **Ethylene—Kellogg**	R9	PDS 13, **Thermofor Catalytic Reforming**	R34
PDS 5, **Fluid Coking**	R10	PDS 14, **Process Reference—1956**	R37
PDS 6, **Chemico Urea**	R16	PDS 15, **Ammonium Nitrate**	R39
PDS 7, **Ethylene—Stone & Webster**	R18	PDS 16, **Chemico Nitric Acid**	R41
PDS 8, **TCP—Socony Mobil**	R21	PDS 17, **H_2SO_4 Alkylation**	R44
PDS 9, **Process Reference—1947**	R24		

PDS 18, **Process Refrence List—1954** R48

Engineering Data Sheets contain basic data and information on a variety of subjects. 2 pages—$0.20 each, or any 6 EDS or PDS sheets for $1.00.

EDS 1, **Pressure Fundamentals**	R7	EDS 9, **Heat Fuel Comparison**	R27
EDS 2, **Temperature Fundamentals**	R11	EDS 10, **Tank Capacities—II**	R29
EDS 3, **Fluid Flow Fundamentals**	R13	EDS 11, **Measuring Viscosity**	R33
EDS 4, **Flow Restrictions in Pipe**	R14	EDS 12, **Metals Glossary**	R35
EDS 5, **Tank Capacities—I**	R17	EDS 13, **Plastics Glossary—A-L**	R38
EDS 6, **Heat—and Its Transfer**	R19	EDS 14, **Plastics Glossary—M-Z**	R40
EDS 7, **Vapor Pressure**	R22	EDS 15, **Combustible Vapors**	R42
EDS 8, **Distillation Fundamentals**	R25	EDS 16, **Instrument Terminology —A-F**	R45

EDS 17, **Instrument Terminology—G-P** R-49

LESS "LOST TIME" with AIRETOOL

You'll keep plant production and efficiency way up... practically eliminate costly down-time due to tube failure, with AIRETOOL Condenser Tube Maintenance equipment. Even at "turn-a-round" time, lost stream. time is kept to a minimum. Repair, removal and replacement of tubular equipment is accomplished faster, easier and at less cost, with AIRETOOL equipment on the job.

Don't wait... investigate all the advantages of AIRETOOL Condenser Tube Maintenance Equipment now. There's a precision built AIRETOOL tube maintenance tool for every type of tubular construction. See your nearest AIRETOOL Representative today... or write AIRETOOL MFG. CO., Springfield, Ohio, for information.

NEW INTERNAL TUBE CUTTER
quickly removes damaged or leaky tubes. Cuts through steel or non-ferrous tube sheets to 4" thick. Air or electric driven motor.

NEW PUSH-TYPE INTERNAL TUBE CUTTER
for non-ferrous tubes 5/8" to 1" O.D. cuts through tube sheets 1" to 4" thick. Operates on your own air or electric motor.

CONDENSER CLEANERS
outside mounted, direct or gear driven. Powerful . . . fast . . . lightweight . . . for lightly scaled or completely plugged tubes. Built in flushing system cools drill, removes cuttings.

CONDENSER TUBE EXPANDERS
parallel rolling, self-feeding, ball bearing thrust. Rolls tubes to uniform thickness, with maximum bonding.

AIRETOOL MIDGET CLEANERS
for lightly scaled tubes. Small, powerful, excellent for cleaning small tubes with extremely short radii turns or hairpin bends.

Send for Bulletin #59, illustrating the complete new line of AIRETOOL Tube Cutters, cleaners, expanders, accessory and specialty tools.

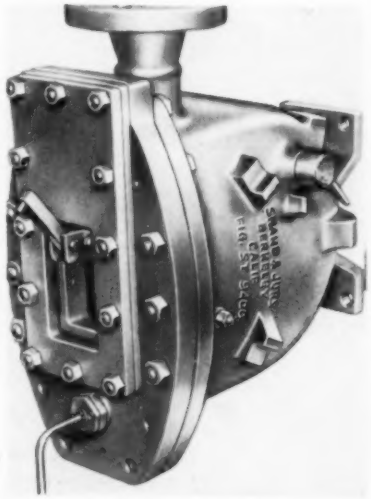
AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES: in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
EUROPEAN PLANT: Vlaardingen, The Netherlands.
CANADA PLANT: 37 Spalding Dr., Brantford, Ont.

spots" to prevent threading to any pre determined length, fractional or other wise.

The use of this chuck requires three steps. First, thread one end of any pipe to the desired diameter and cut to length. Clamp the nipple chuck in either a vise or power drive and screw the "bald" nipple into the holding bushing. Then, thread in the usual manner. **Mercury Hydraulics, Inc.**, 2440 Blake St., Denver 5, Colo.

Circle No. 10 on Reply Card



Automatic tank gage

. . . for products under pressures of from 150 to 300 psi. The unit uses a constant torque spring, which exerts a restraining force that does not increase as the elastic member is extended. Thus, consistent tape readings regardless of the position of the float are possible.

The gage assembly includes an 18-8 stainless steel tape graduated in eighths of an inch and a tubular aluminum pressure float. A stainless steel float is available if desired. The gage is for both ground and roof readings. **Shand & Jurs Co.**, Berkeley, Calif.

Circle No. 11 on Reply Card

Fluorescent lamp

. . . is waterproof and explosion-proof and suitable for rough usage, even for underwater use.

Made in Switzerland, the Tubline lamps are mounted in a light casing that screws together. Thick transparent plexiglas protects the tube and permits no interference in light transmission. When the casing is unscrewed to replace the lamp the current is automatically cut off.

The lamps are designed for stand-

Are YOU Looking for a BETTER Job?

Petroleum Processing is again expanding its editorial staff, and its editors are looking for a man with technical training to fill the opening of assistant editor.

The job offers the man we select an interesting opportunity in an exciting field of activity. He will have the chance to get better acquainted with the broader aspects of the petroleum processing industry, to meet and talk with its top-notch technical people, to be "in the know" about new developments in the industry even before they are announced. He will be affiliated with a dynamic, fast-moving publication, backed up by the largest and most progressive business magazine publishing firm in the world.

Here are the specifications:

Education: If you are the man we want, you're a graduate engineer, with a B.S. in chemical engineering or industrial engineering, with perhaps a few extra courses in business or economics. You were in the top third of your class scholastically.

Industry Experience: You have had some practical experience (although maybe only a few years) in our industry. You are now employed by an engineering firm, or in the engineering department of a petroleum or chemical company, and associated in some technical capacity with petroleum refining, petrochemical manufacturing, or natural gasoline recovery. You know the kind of engineers who read Petroleum Processing, and the kind of problems they are up against.

Writing Experience: You have probably never thought of editorial work as a career, but you've been writing reports in connection with your work and found satisfaction in putting information down on paper in a clear, logical, organized manner. You may have done some writing as a hobby, or even have worked on a high school, college or similar paper or magazine. You can express yourself well.

Personality: You are curious about "why" and "how" things work, and you have the ability to explain their workings to others. You are able to organize your own work, and you have initiative to push ahead and get things done. You like meeting people and talking with them, yet at the same time you are a good listener. You are not a "glad-hander."

Location and Duties: You would welcome the chance to work in New York City, and you don't mind sitting behind a desk for a while, editing and rewriting other people's copy. Later (just as fast as you learn the ropes) you expect that you'll be given field assignments to gather data and write original articles.

Salary: You are now earning a respectable salary, and the chances are that this position will pay you even more right now—besides offering you the opportunity to rise more rapidly than you now expect to.

• If you think you are the man we want, send details on your background and experience (including salary history) to

William F. Bland, Editor
Petroleum Processing
330 West 42nd Street
New York 36, N. Y.

• If we think you are a qualified candidate, we will make arrangements for a personal interview. All replies will be held in the strictest confidence.

The stoutest pipe vise
. . . with built-in
folding legs and tray

RIGID
Tristand Pipe Vise

Extra easy to fold up, carry and set up . . . Extra strong, extra rigid in use

Every RIGID Pipe Tool TESTED individually before shipment

Most service and durability for your money! Integral legs and tray mean quick easy fold-up for carrying and set-up for work—provide solid stance, greater strength. Vise base is roomy, has ceiling brace screw, pipe benders, slots for tools. Special LonGrip jaws grip tight without chewing up pipe. Save work—see it, try it, buy it at your Supply House.

RIGID Tristand Pipe Vise, yoke model.
Chain model also available.

The Ridge Tool Company, Elyria, Ohio, U. S. A.

RIGID
Work-Saver Pipe Tools

ard voltages of 220, 145, 125, 110 and 36 volts., in 50 cycle alternating current. **Trans Electric,** Rue Dassier 8, Geneva, Switzerland.

Circle No. 12 on Reply Card

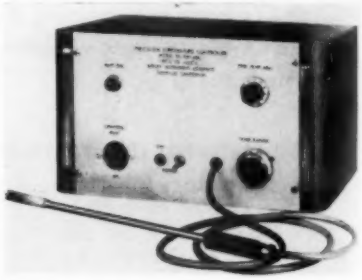
Remote operation

. . . of valves, gates, feeders and other devices is possible with this Synchro-Scan Indicator Controller.

Remote modulation and continuous indication is accomplished through a plug-in transmitter unit, pictured above. Mounted on its face is a 3-position switch for controlling the remote device. A small voltmeter indicates the percent opening of the remote unit.

At the receiving end is another packaged unit, which contains the control relays and regulated DC voltage supply for transmitting the position indication. Only two wires and a ground are required for transmission of the signal. **Builders-Providence, Inc.,** 345 Harris Ave., Providence, R. I.

Circle No. 13 on Reply Card



Temperature controller

. . . is accurate to 0.001°C and covers a temperature range of −100° to +500°C.

The operation of the controller is simple. Coarse and fine dial setting

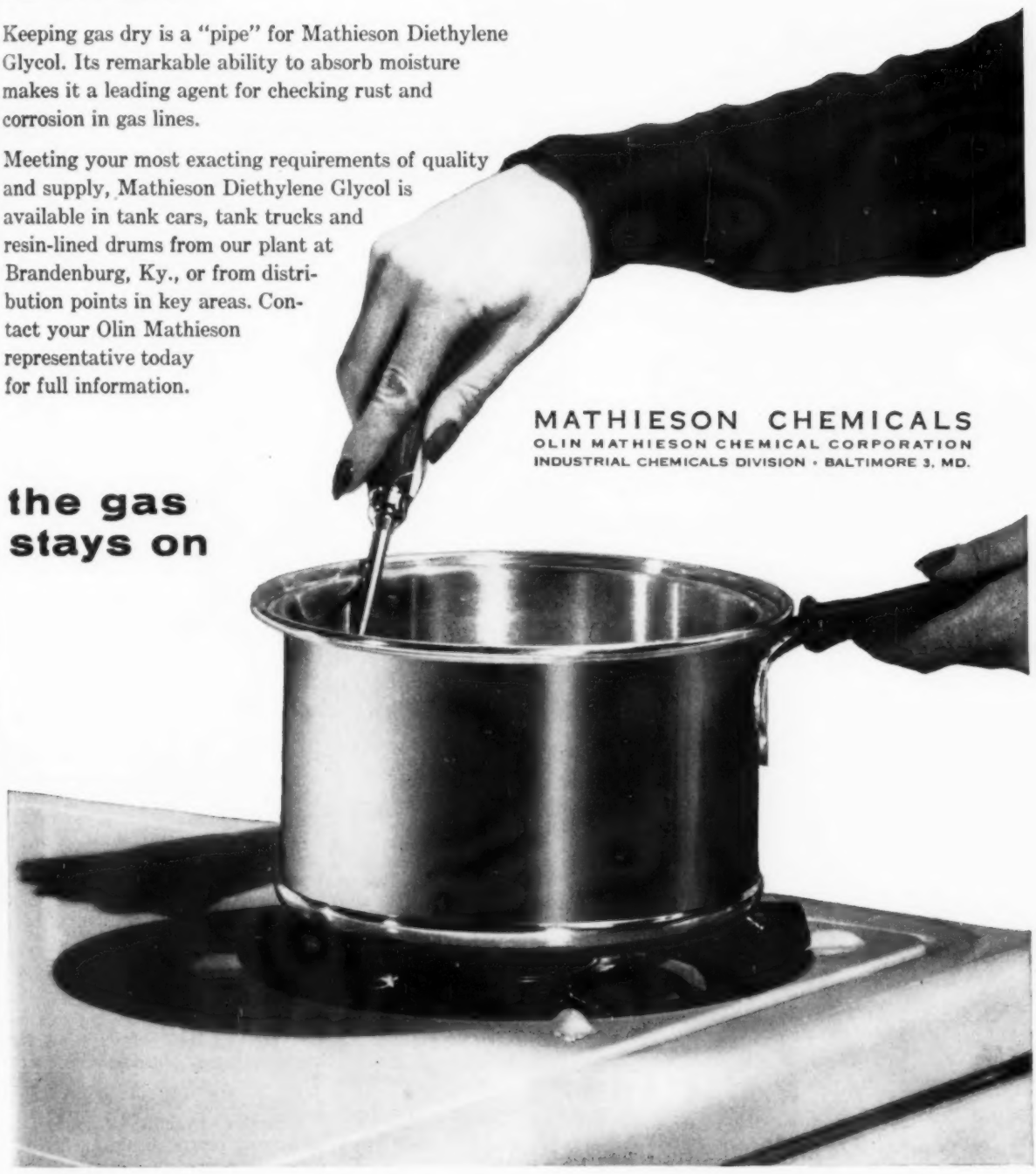
When Mathieson DIETHLYENE GLYCOL is there

Keeping gas dry is a "pipe" for Mathieson Diethylene Glycol. Its remarkable ability to absorb moisture makes it a leading agent for checking rust and corrosion in gas lines.

Meeting your most exacting requirements of quality and supply, Mathieson Diethylene Glycol is available in tank cars, tank trucks and resin-lined drums from our plant at Brandenburg, Ky., or from distribution points in key areas. Contact your Olin Mathieson representative today for full information.

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD.

the gas stays on



MATHIESON

INORGANICS: Ammonia · Bicarbonate of Soda · Carbon Dioxide · Caustic Potash · Caustic Soda · Chlorine · Hydrazine and Derivatives · Hypochlorite Products · Muriatic Acid · Nitrate of Soda · Nitric Acid · Soda Ash · Sodium Chlorite Products · Sulfate of Alumina · Sulfur (Processed) · Sulfuric Acid

ORGANICS: Ethylene Oxide · Ethylene Glycols · Polyethylene Glycols · Glycol Ether Solvents · Ethylene Dichloride · Dichloroethylether · Formaldehyde · Methanol Sodium Methylate · Hexamine · Ethylene Diamine · Polyamines · Ethanolamines · Trichlorophenol · Surfactants

 (To obtain more data on advertised products see page 280)

What is it?

It's a bubble-cap, encrusted with carbon, out of a fractionating tower just before in-place circulation cleaning with Oakite 85.

Recognize it now?

Same bubble-cap . . . after tower cleaning by Oakite chemical circulation methods that insure superior results with less down-time.

★ ★ ★

There's an Oakite specialized cleaning material for just about every maintenance cleaning job throughout the petroleum industry. For FREE 46-page booklet, "What Petroleum Men Should Know to Simplify Cleaning," write to Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE®
MATERIALS · METHODS · SERVICE
SCIENCE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

select the desired temperature. No adjustment of the thermometer is necessary. One pilot light on the panel indicates when the instrument is turned on and the other light shows when energy is being supplied to the control heater or other equipment.

Power requirements are 15 amp, 115 volts on 60 cycles. The heater load is handled through a sealed mercury-to-mercury relay, thus eliminating any hazardous arcing or contact wear. The unit is electrically fused and equipped with a 3-wire grounded power cord. **Bayley Instrument Co.**, Box 538, Danville, Calif.

Circle No. 14 on Reply Card

Cast steel solenoid valve

. . . features renewable seat rings, unbreakable piston rings and packless operation over a wide pressure range. Maximum pressure rating is 600 psi.

The solenoid coils are unconditionally guaranteed, with Greenclad waterproof molded coils for temperatures to 250°F. For higher temperatures, silicone insulated coils are available. Sizes range between 2 and 4-in. Design can be either globe or angle pattern with screwed or flanged pipe ends. **J. D. Gould Co.**, 4707 Massachusetts Ave., Indianapolis 18, Ind.

Circle No. 15 on Reply Card

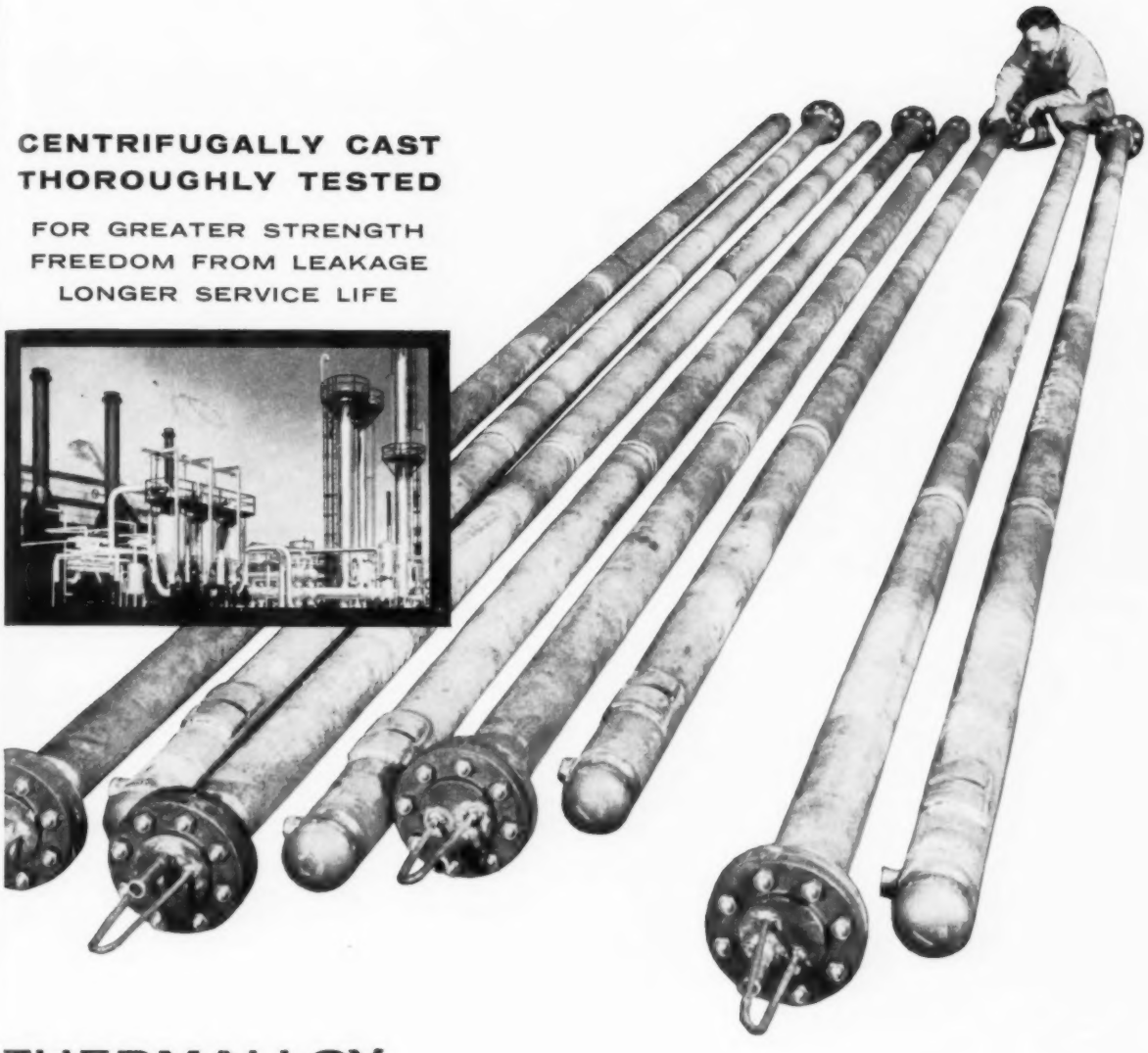
Nitrogen generator

. . . uses a platinum catalyst to produce nitrogen with any hydrogen content between 0.25 and 25%. Fully automatic, the Nitroneal generator draws nitrogen from both the air and a supply of ammonia.

Because the reaction is exothermic, no external heat is required. The only connections needed are a 110-volt electrical receptacle, a drain outlet, and single lines for water, air and ammonia. These portable nitrogen generators range in size from 50

CENTRIFUGALLY CAST
THOROUGHLY TESTED

FOR GREATER STRENGTH
FREEDOM FROM LEAKAGE
LONGER SERVICE LIFE



THERMALLOY
REFORMER FURNACE TUBES

The Thermalloy* Reformer Furnace Tubes you see above are designed to operate at 1820° F.—with internal pressure of 150 psig. To insure freedom from leakage and long service life, the individual cast tube sections underwent a hydrostatic test of 3000 psi. In addition, each assembly was tested at 900 psi.

Tube sections are centrifugally cast to specified diameters—to insure greater density, finer grain structure and uniform thickness. And experienced Electro-Alloys metallurgists and engineers can help you select the grade of high-heat-resistant Thermalloy best suited to your particular application.

Recent expansion of Electro-Alloys' centrifugal casting facilities means we can meet your needs for Reformer Tube Assemblies promptly. Call your nearby Electro-Alloys representative. Or write for Bulletin T-283. Electro-Alloys Division, 8075 Taylor Street, Elyria, Ohio.

**Reg. U. S. Pat. Off.*

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

(To obtain more data on advertised products see page 280)

PHOTO - COURTESY SERVICE PIPE LINE COMPANY

VAREC PULSE CODE RECEIVER INSTALLATION AT FT. LARAMIE STA. OF SERVICE PIPE LINE COMPANY

"Varec" PULSE CODE telemetering

Tailored To Your Needs...

In addition to giving an accurate signal on liquid level readings over long distances and doing it in the record time of 5 seconds, the "Varec" PULSE CODE Telemetering System can now perform a great variety of operations. Some idea of the system's flexibility can be obtained by checking these optional features:

1. Pulse Code Receivers with provisions for indicating liquid level, temperature, motor valve or other equipment status, abnormal or alarm conditions and other data as required.
2. Systems incorporating two or more receivers.
3. Systems incorporating two or more receivers and selectors.
4. Receiver with terminal provisions for connecting with data printer.
5. Digital clock to be used in conjunction with data printer.
6. Serial entry data printer such as an electric typewriter.
7. Parallel entry data printer such as a ribbon type adding machine.
8. Data Programmer to link Pulse Code receiver to data printer.
9. Contactor units to provide "on — off" remote control of equipment such as pumps, motor-driven valves, etc.
10. Scanner unit to provide automatic scanning for data logging on a pre-determined time schedule.

With this wide selection of combinations, your "Varec" PULSE CODE System can be custom-built for your particular process..

Write for "Varec" Bulletin CP-3011 for full details of "Varec" PULSE CODE Telemetering.

961-20

THE VAPOR RECOVERY SYSTEMS COMPANY

"Varec"

2820 North Alameda Street
Compton, California

Cable Address:
Varec Compton Calif (U.S.A.) All Codes

standard cu ft per hour to 10,000 scfh. **Baker's Instrument Division,** 207 Grant Ave., East Newark, N. J.

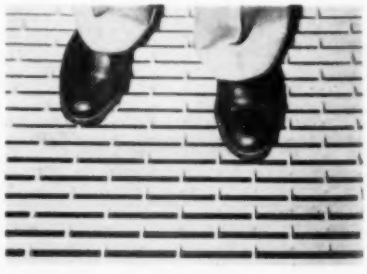
Circle No. 16 on Reply Card

Portable sump pump

. . . handles inflammable liquids and resists corrosion because of its materials of construction. The pump body, impeller and strainer are of bronze. The shaft is stainless steel. Bearings are double-sealed to protect them and the air motor from contamination.

The pump requires no priming. Speeds vary between 3200 and 3600 rpm, depending upon the head against which it is pumping and the supplied air pressure. It will operate with 60 psig air, pumping 234 gpm against a 10 ft head. With 100 psig air it will handle 410 gpm against 10 ft of head. **Schramm, Inc.,** 900 East Virginia Ave., West Chester, Pa.

Circle No. 17 on Reply Card



Aluminum grating

. . . has 79% clear rectangular openings in a design that retains structural rigidity regardless of the cutouts. Joining of the all-aluminum grating is by riveting.

Grating of this design offers the advantage of resistance to corrosive at-

you can meet any lubrication specification if you

BLEND WITH ENJAY PARATONE®

(VISCOSITY-INDEX IMPROVERS)

Base stocks blended with Enjay Paratone can be compounded into lubricants combining cold-weather quick starting properties with high temperature, low consumption characteristics. These lubricants are *all-season* oils, featuring improved gas mileage. More and more refiners and blenders are relying exclusively on Paratone to produce the high "VI" required in these all-season oils.

Through years of intensive research and development work with automotive manufacturers, Enjay has developed the only *complete line* of high quality additives (Paramins®) that can assure *maximum* performance characteristics. Why not let this experience and know-how work for *you*? Write, wire or phone the Enjay Company.

ENJAY

Pioneer in Petrochemicals

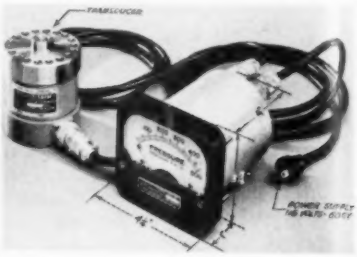
ENJAY COMPANY, INC., 15 WEST 51st ST., NEW YORK 19, N. Y.

Akron • Boston • Chicago • Los Angeles • New Orleans • Tulsa

REVAMPS
Require Specialized
Engineering Skill
Our wide experience in this field and the flexibility of our organization assure maximum performance with minimum down time.
The illustration shows a portion of the revamp gas recovery system of a large crude unit recently completed for Sohio.
The
C. W. NOFSINGER
Company
Kansas City, Mo.

mospheres, plus easy cleaning. It meets the Navy Military Specifications for design and strength for gratings to be installed aboard ship. **Klemp Metal Grating Corp.,** 6601 South Melvina, Chicago 38, Ill.

Circle No. 18 on Reply Card



Telemeter indicator

. . . shows information from remote strain gage-type transducers. Pressure, thrust, torque and other remote readings can be measured by a transducer in an explosive location and transmitted to a control room using this Teledyne indicator.

Accuracy of the meter is 1% of full scale, with an overall system accuracy of 2% of full scale. It is designed for ambient temperatures of 0.0° to 120°F. Response time is ½-sec. Adjustments for mechanical zero, electrical zero and calibration are made on the front of the instrument. **Taber Instrument Corp.,** 111 Goundry St., North Tonawanda, N. Y.

Circle No. 19 on Reply Card

D/P pickup

. . . for corrosive or conductive fluids senses pressure differentials from ±½ psi to ±1000 psi at line pressures up to 2000 psi.

Pressure differences are transmitted from a single diaphragm through a

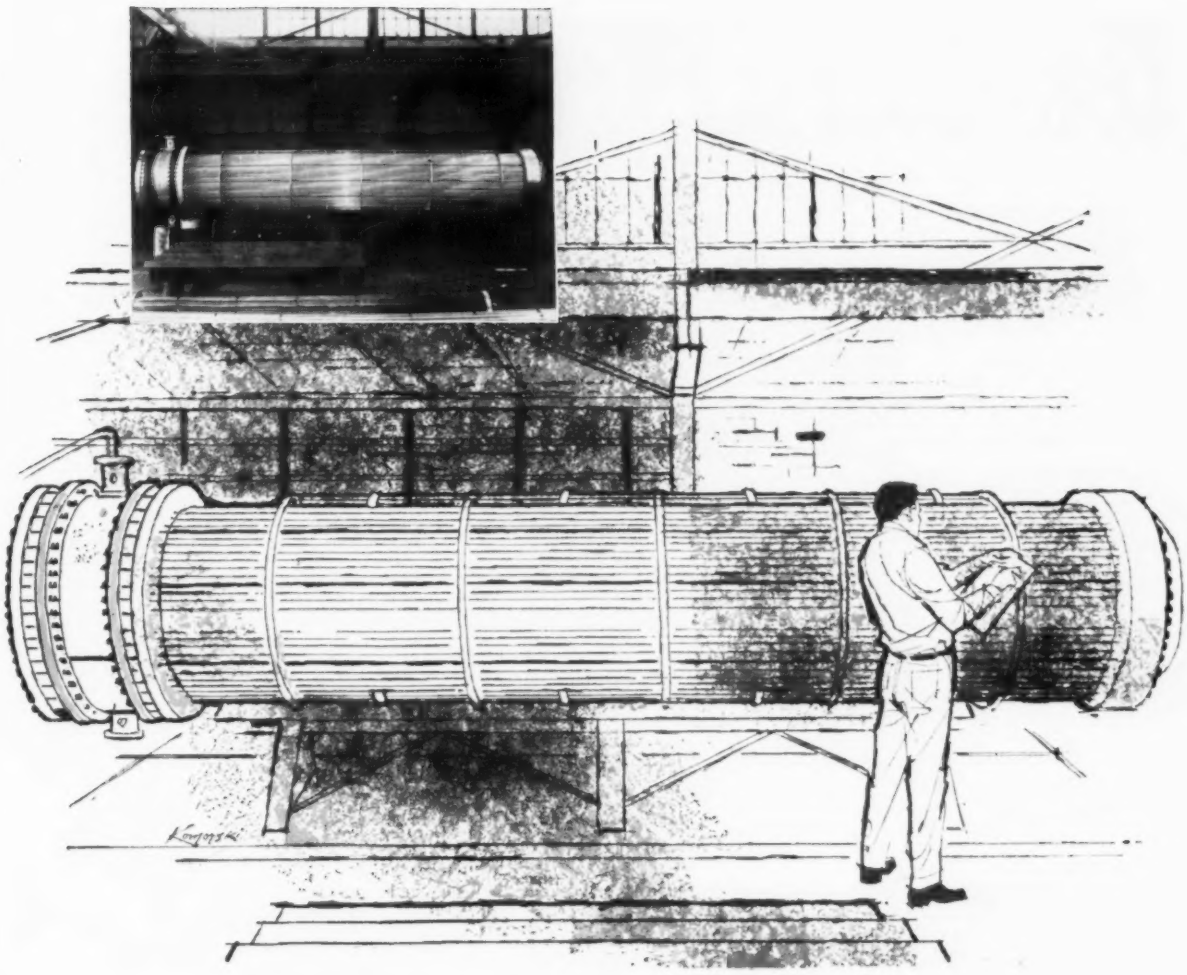
Are You Moving?

Please let us know as soon as you can so we can change your subscription stencil addressing plate. Be sure to send us

(1) Your *old address* (including company connection)
(2) Your *new address* (including company connection)
(3) The *date* the change becomes effective

PETROLEUM PROCESSING—Subscription Department
330 West 42nd Street—New York 36, N. Y.

(To obtain more data on advertised products see page 280)



WESTERN SUPPLY SPECIFIED ALCOA ALUMINUM ALL THE WAY

on these 100% aluminum Dilution Coolers

The exchanger illustrated is one of a number furnished by Western Supply Company, Tulsa, Oklahoma, for a recent low-pressure polyethylene installation. They selected Alcoa® Aluminum for this service because of its protection of product color and stability, good heat transfer properties and corrosion resistance. For the same reasons, aluminum has also found wide use in ammonium nitrate cooling, sour gas treatment and many low temperature processes.

As Western Supply Company sums up the case for Alcoa Aluminum Heat Exchangers: "In our experience Alcoa Aluminum is a sound, low-cost solution to many of the problems encountered in petroleum refining, natural gasoline manufacturing, petrochemical and chemical processing."

If *you* have heat transfer problems affecting tubes or other components of either the channel or shell side, investigate aluminum! Aluminum offers corrosion resistance and good heat transfer properties at minimum cost, and has excellent physical properties at extremely low temperatures. Get details in the FREE BOOKLET, *Alcoa Aluminum Heat Exchanger Tubes*. Mail the coupon today!

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA
893-E Alcoa Building, Pittsburgh 19, Pa.

☐ Send me the FREE BOOKLET, Alcoa Aluminum Heat Exchanger Tubes.

☐ My heat exchanger problem is:

Name _____ Title _____

Company _____

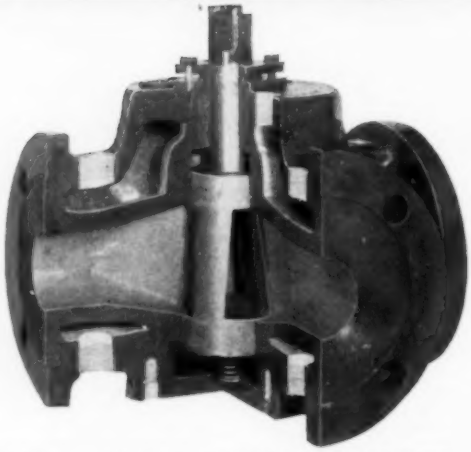
Address _____

City _____ Zone _____ State _____

(To obtain more data on advertised products see page 280)

Jacketed Spring Loaded
PLUG VALVES

- 2-WAY OR STRAIGHT SPRING LOADED
- 3-WAY SPRING LOADED
- ANGLE SPRING LOADED
- AIR CYLINDER OPERATED SPRING LOADED—*all sizes and types*



LONG ON SERVICE...SHORT ON MAINTENANCE

H & B's new fully jacketed spring loaded plug valves feature an inverted tapered plug inserted and lapped into the housing from the bottom of the valve—then spring loaded. The spring wedges the plug to a perfectly tight seal, eliminating troublesome leaks. Easy to operate—no big handwheel . . . no freeze . . . no "breaking loose" necessary. Easy to clean. Made in two port or multi port design, with any special stop arrangement desired.

Bulletin J-57 sent on request

HETHERINGTON & BERNER INC., 715 Kentucky Ave., Indianapolis 7, Ind.

Now...a fully-Armoured
FLOW INDICATOR
simple as...

1 There's not a single stuffing box, yet this Model 3602 Armoured Flow Indicator handles pressures to 3000 psig; temperatures to 500° F. Eight ranges cover flows from 1.5 to 1200 GPH water. It's all metal with a positive-bond magnetic indicating follower and only 7 inches high.

2 Disassembly is the simplest ever... without removal from the line. Head is rotatable.

3 Cleaning is a snap...so are range changes. Metering plug and interchangeable orifice simply lift out. Plug seat automatically checks back flow.

Send for Bulletin 360

BROOKS ROTAMETER COMPANY
101 Eighth Street • Lansdale, Pa.

mechanical linkage to an unbonded strain-gage element. Isolation of the strain-gage element is accomplished by a double chamber arrangement so that only teflon and 18-8 stainless steel parts come in contact with the corrosive fluid.

Standard units operate with either ac or dc excitation at 6, 12 or 15 volts. Measurements are accurate to ½% of full scale at 70°F. Temperature is —65° to 350°F. The output signal resulting from the line pressure of 2000 psi is less than 1% of full-scale output. **Dynamic Instrument Co., Inc.,** Cambridge, Mass.

Circle No. 20 on Reply Card

Plastic fittings

. . . **for drainage lines** eliminate conventional bell and spigot cast iron lines.

Made of polyvinyl chloride, these fittings are less expensive to install than cast iron drainage pipe. Installation to PVC pipe is simple, requiring only a can of cement and a brush. The solvent welded joints will hold tight under corrosive conditions and vibrating stresses.

Socket type solvent welding fittings are made by injection molding techniques, and are claimed to be appreciably stronger than PVC fittings made by conventional molding processes, on a strength-to-weight basis. **Tube Turn Plastics, Inc.,** 2929 Magazine St., Louisville 11, Ky.

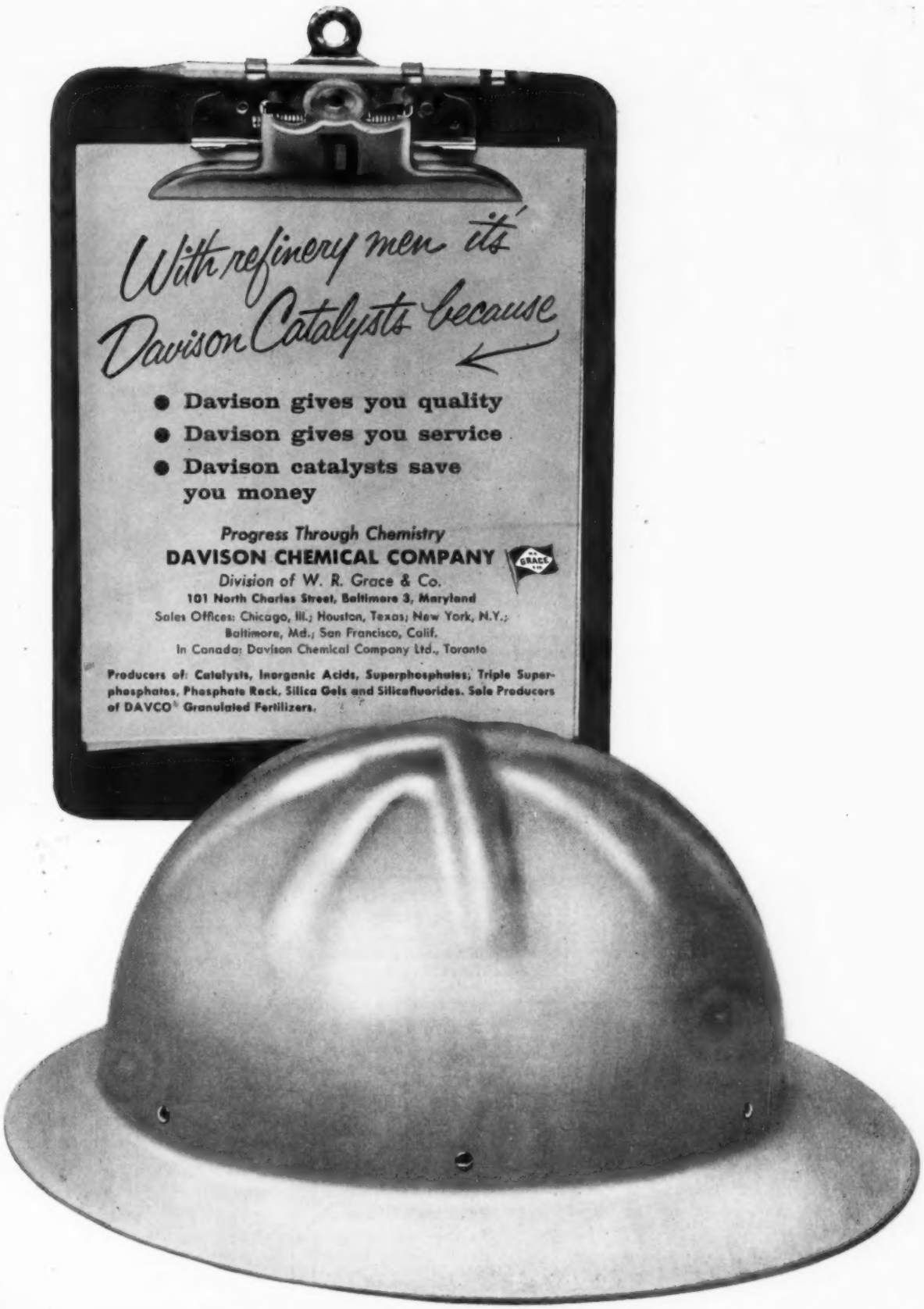
Circle No. 21 on Reply Card

Flareless fittings

. . . **make a butt-tight joint** that is designed for a full range of pressure conditions. Tubing need not be sprung when making assemblies.

Available in steel or stainless steel,

(To obtain more data on advertised products see page 280)


With refinery men it's
Davison Catalysts because
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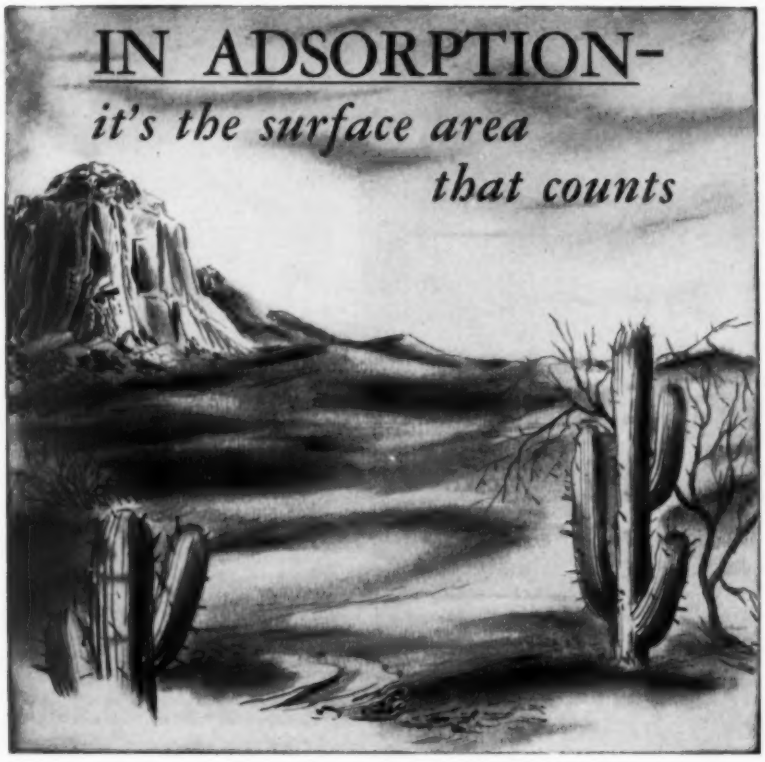

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the Hi-Seal fittings consists of a body, nut and alloy sleeve. A shoulder on the sleeve prevents incorrect assembly even by inexperienced personnel. The three serrated edges of the sleeve, which bite radially into the tube surface, prevent longitudinal movement and make a triple seal.

This seal avoids any need for flaring and may be re-used often while still maintaining a positive seal. It may be used with steel, stainless steel, copper, aluminum, everdur and monel tubing; and it will remain pressure-tight beyond the burst-strength of the tubing itself. The fitting is available in sizes from ⅛- to 1½-in. O.D. tubing, and can be furnished with pipe threads or straight threads with O-ring seal. **Imperial Brass Mfg. Co.,** Dept. HSF, 1200 Harrison St., Chicago 7, Ill.

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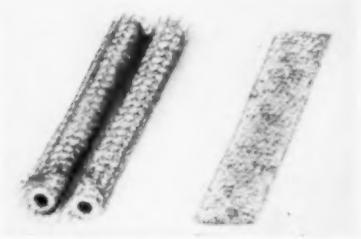

Tray gasket

. . . **resists high temperatures** and is easy to install.

Metex Tray Seal is made of pure asbestos fiber and knitted Monel wire. This type of construction permits tray bolts to be pushed through the gasketing material as it is laid in place. There is no need to locate and punch holes before installing.

Under operating tests this asbestos-

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Carbon Monoxide Boiler at Sun Oil Company's Toledo refinery.

3 B&W Carbon Monoxide Boilers Save Fuel For Sun Oil

Sun Oil Company has three B&W Carbon Monoxide Boilers in its refineries at Toledo, Ohio, and Marcus Hook, Pa. All are used with Houdriflow cracking units. The first boiler went on stream at Toledo three years ago. The second, at Toledo, and its twin at Marcus Hook, are of the oxycatalyst type.

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Cracking units at Sun Oil, like others using B&W "CO" Boilers, are completely independent of outside steam and energy sources at all times. Whether or not the cracking unit is operating, steam is always available.

Extended, sustained service has proved the reliability, efficiency, and economy of B&W "CO" Boilers in refineries throughout the nation. They are flexible in design and arrangement to meet varying refinery conditions. B&W engineers can show you how a "CO" Boiler can serve your refinery, regardless of size, steam pressure and temperature requirements. The Babcock & Wilcox Company, Boiler Division, Dept. PP-2, 161 East 42nd Street, New York 17, N. Y.

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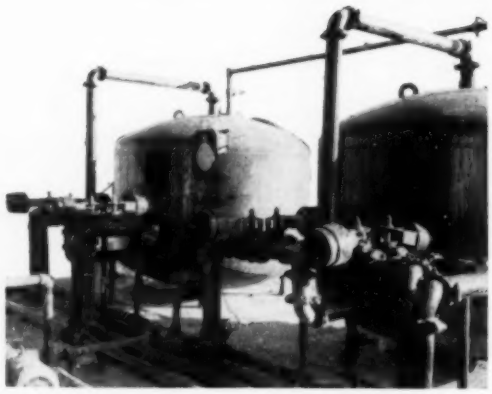
BOILER DIVISION

ONLY DeZurik MAKES THE EASY-OPERATING PLUG VALVE WITH ECCENTRIC ACTION!



DeZurik gas operated valves on water filters at the Mid-Burbank Water Flood Project operated by Phillips Petroleum Company, Osage County, Oklahoma.

Whether it's dead-tight shut-off you want in a a valve . . . or easy operation . . . or freedom from constant maintenance, you'll find the answer in DeZurik Plug Valves. *Exclusive* eccentric action guarantees easy, trouble-free operation; resilient plug-facing assures leak-free closure—every time! On any line! Even when automatically operated.

DeZurik Valves are available in sizes from ½" thru 20", in a full range of metals, and for manual, pneumatic hydraulic or electric operation. Representatives in all principal cities; or, for more details on DeZurik Plug Valves, write

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SARTELL, MINNESOTA

wire gasketing has successfully replaced conventional asbestos-cotton tape, has reduced the tray leakage, and stood up under temperatures of 750°F. **Metal Textile Corp.,** 645 E. First Ave., Roselle, N. J.

Circle No. 23 on Reply Card

Free trade literature

Liquid-gas separator

. . . for removal of entrained liquids and solids from air, gas and steam systems: *Bulletin S-1052* describes the Selas Liqui-Jector which completely removes suspended liquid and solid particles from process and instrument gas supply lines. Standard models handle up to 7,000 cfm and pressures up to 200 psig. Selas Corporation of America, Dresher, Pa.

Circle No. 24 on Reply Card

Mechanical seals

. . . for rotating equipment: *Catalog #480* describes the different types of seals which meet operating requirements for temperature, pressure and fluid conditions. Each seal is illustrated with a cutaway view showing stuffing box installation details. Durametallic Corporation, 2104 Factory St., Kalamazoo, Mich.

Circle No. 25 on Reply Card

Expansion joints

. . . of many types are described in detail in a 72-page publication, *Catalog 56*. Introduced in the catalog are details on new staff equalizing, duo equalizing, and high pressure toroidal expansion joints. Essential data on 9 other types are also included. Tables and charts present complete engineering specifications. A selection chart tells how to choose the correct expansion joint for a given set of conditions. Zallea Brothers, Taylor and Locust Street, Wilmington 99, Del.

Circle No. 26 on Reply Card

Bronze & steel valves

. . . for general industrial use: an 80-page catalog of globe, angle, gate, "Flocontrol" and other types. Engineering data such as material specifications, flow charts, temperature and pressure ratings, etc., are included in the catalog. Manning, Maxwell & Moore, Inc., Stratford, Conn.

Circle No. 27 on Reply Card

Glass

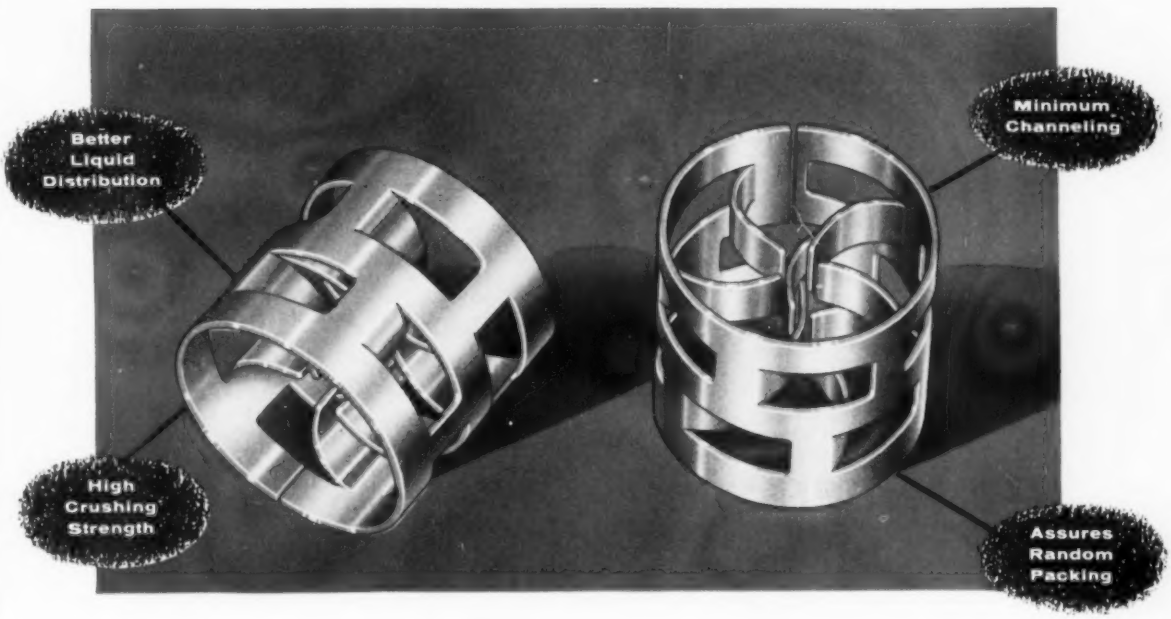
. . . and how it's made, how it's used and what it is: *This Is Glass*, a 64-page informative booklet about one

(To obtain more data on advertised products see page 280)

A new step forward in Tower Packings

METALLIC PALL RINGS

• Lower Pressure Drop • Better Mass Transfer Efficiency
• Lower H.E.T.P. Characteristics



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In absorption, distillation or extraction the new patented Pall Ring offers advantages of major importance. They are now available in three sizes: 1", 1½" and 2" in carbon steel, stainless steel, aluminum and copper. Typical data appears in the table below.

O.D. and Length (inches)	Wall Thickness	Number per Cubic Foot (approx.)	Weight per Cubic Foot in lbs. (Carbon Steel)	Surface Area (sq. ft./ cu. ft.)	Per Cent Free Gas Space
1"	24 Gauge	1520	33	66.3	93.4
1½"	22 Gauge	490	30	48.1	94.0
2"	20 Gauge	210	27.5	36.6	94.1

Write for this new booklet!

Technical data and full specifications on the complete line of U. S. Stoneware Tower Packings, including the new Pall Ring. Ask for Bulletin TP-54.

U. S. STONEWARE
AKRON 9, OHIO

(To obtain more data on advertised products see page 280)

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JOHN ZINK

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* Oil spillage cannot cause gas burner plugging.

If the oil can be pumped, the "DA" can burn it.

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of man's oldest chemical products. Included are many pictures showing how glass was manufactured in olden days, and the recent progress in manufacturing this modern material. Many types of glass, their uses, their properties and their uses in the future are all described. Corning Glass Works, Corning, N. Y.

Circle No. 28 on Reply Card

Combustion safeguards

. . . for preventing flashback in combustible mixture supply lines: *Bulletin SC 1006* is a recent revision describing the operation and construction of these Fire Checks that detect, localize and extinguish flashbacks. Sometimes these units are considered as "fuses" and "circuit breakers" in a combustible vapor supply line. Selas Corp. of America, Dresher, Pa.

Circle No. 29 on Reply Card

Transducer

. . . converts linear measurements into electrical responses, to be used for remote indication, remote control, computation or amplification: *Bulletin AA-1a* is a 19-page brochure that clearly explains in detail the operation of the linear differential transformer type of transducer. Schaevitz Engineering, P.O. Box 505, Camden 1, N. J.

Circle No. 30 on Reply Card

Plastic-coated pipe

. . . combines the strength of steel and the corrosion resistance of plastic: *ADV. 770* describes the method of producing a steel pipe with a permanently-bonded polyethylene coating, and how it can be used advantageously in many applications. Republic Steel Corp., 3100 East 45th St., Cleveland 27, Ohio.

Circle No. 31 on Reply Card

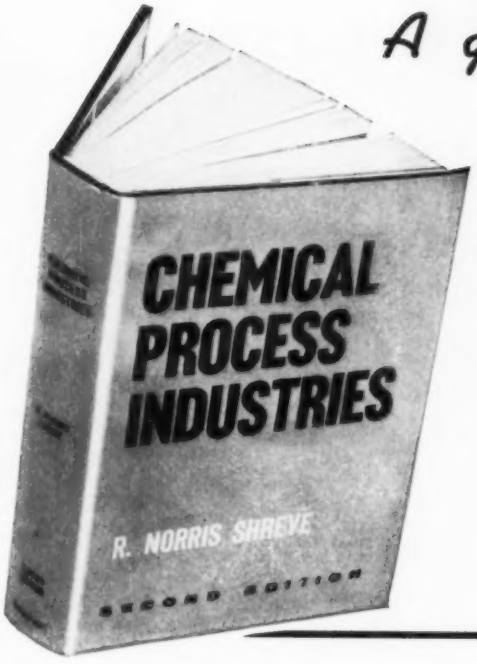
Storage tank fittings

. . . to cut evaporation losses: *Catalog No. 66* describes a new line of tank fittings which includes water drain valves, automatic tank gauges, level indicators and gauge hatches. Described also is a new screened free vent which provides free flow of air and vapor. Wheaton Brass Works, Union, New Jersey.

Circle No. 32 on Reply Card

Training aid

. . . for high school students interested in the skilled trades: *Your Opportunities In Industry as a Skilled Craftsman* is a 32-page booklet to encourage young people to consider



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by R. Norris Shreve

Consulting Chemical Engineer, Professor of Chemical Engineering, Purdue University

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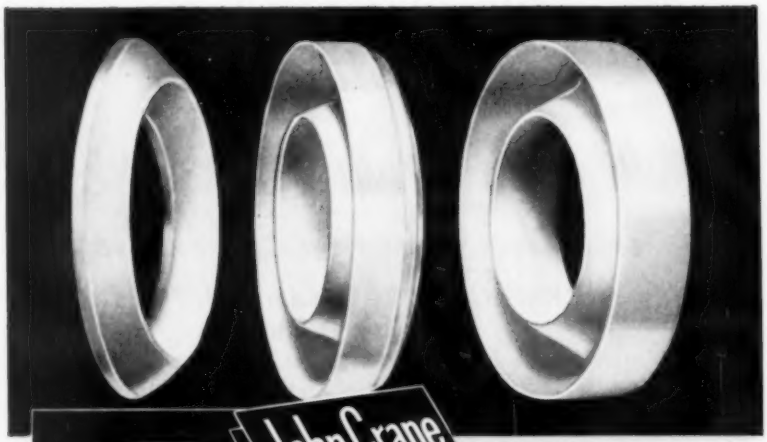

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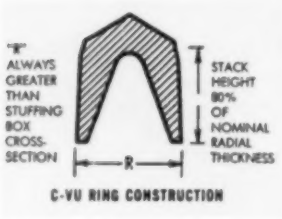
ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

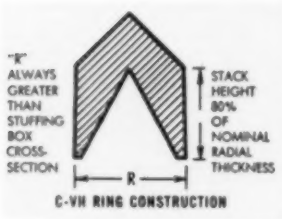
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



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Crane Packing Co., 6432 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

CRANE PACKING COMPANY

this field for their future work. This educational aid is available for use in helping students prepare for their future vocation. It can be obtained from the National Association of Manufacturers, Education Department, 2 East 48th St., N. Y. 17, N. Y.

Circle No. 33 on Reply Card

Finned heat exchangers

. . . for cooling generator windings: *Bulletin 1200* describes the design and construction of G-R K-Fin Coolers for both air and hydrogen circulated through the generator windings in a closed system. This same type of gas cooler can be used for the recovery of solvents from gases, heating, cooling and dehydrating gases, and other applications on chemical process plants. Griscom-Russell Co., Massillon, Ohio.

Circle No 34 on Reply Card

Automation

. . . of electrostatic precipitators eliminates manual adjustments and increases dust and fume collection efficiencies: *Cottrell Automation System* is an illustrated booklet that outlines the operation of this electronic feedback circuit that controls precipitator sparking rates, current and voltage. Research-Cottrell, Inc., Bound Brook, N. J.

Circle No. 35 on Reply Card

Float valves

. . . for maintaining water levels in tanks, reservoirs or mixing chambers: *Bulletin W-5* describes the construction of these cushioned float valves, and how to install and operate them. A pressure drop chart for both globe valves and angle valves of this design is included. Golden Anderson Valve Specialty Co., 1232 Ridge Ave., Pittsburgh 33, Pa.

Circle No. 36 on Reply Card

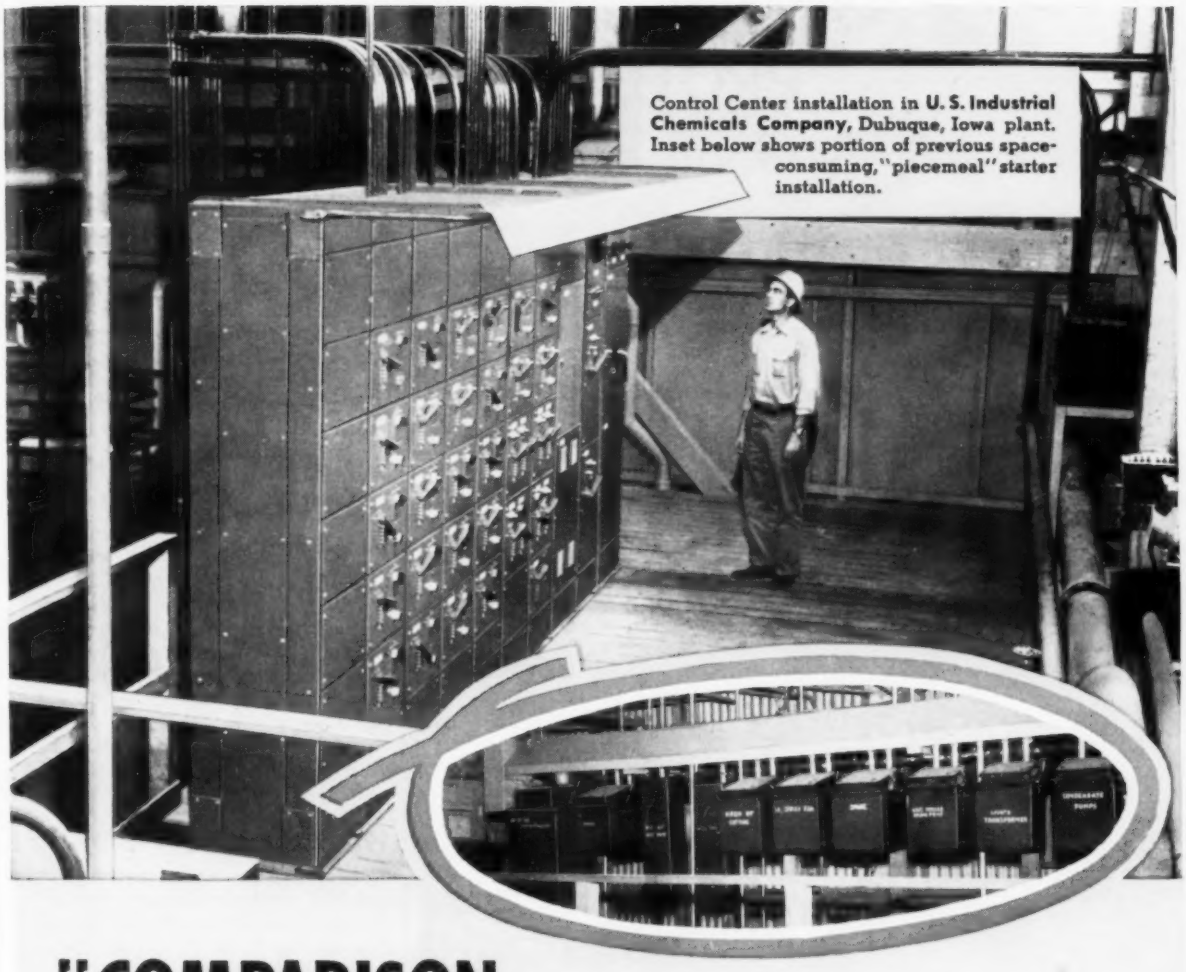
Amines

. . . for fuel additives, corrosion inhibitors, asphalt anti-stripping agents, and many other uses: a 36-page booklet *Tertiary-Alkyl Primary Amines* gives the physical and chemical properties of four amines. Suggested applications and chemical reaction for *t*-butylamine, *t*-octylamine, Primene 81-R and Primene JM-T are listed. Rohm & Haas Co., Washington Square, Philadelphia 5, Pa.

Circle No. 37 on Reply Card

Personnel tests

. . . for selecting and training employes: *Industrial Catalog* helps locate materials needed by personnel and training departments in selecting em-



Control Center installation in **U. S. Industrial Chemicals Company,** Dubuque, Iowa plant. Inset below shows portion of previous space-consuming, "piecemeal" starter installation.

"COMPARISON convinced us that a SQUARE D Control Center offered us MORE!"

These design features make Square D <u>your</u> logical choice, too...

INCREASED SAFETY because bus bars are fully enclosed, rigidly supported and have ample cross section. Circuits are isolated by individually enclosed plug-in units. Disconnect handle designed for maximum operator protection.

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INSTALLATION ECONOMY. All wiring channels are large and accessible from front without removing units. No "wire fishing."

SPACE ECONOMY, TOO. Up to six combination starters fit in a 20" x 20" x 90" section. Plug-in unit heights designed in space-saving increments of 3 inches.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE!

SQUARE D COMPANY

(To obtain more data on advertised products see page 280)

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Combined Ammonia Units in 3 Sizes
Large 2-Cyl. Ammonia Compressors
Large 4-Cylinder Compressors—Up to 700 Hp

ployes, improving their performance and reducing turnover. Included in the catalog are tests of intelligence, interest, and personality, as well as tests for measuring aptitudes and skills. Science Research Associates, 57 West Grand Ave., Chicago 10, Ill.

Circle No. 38 on Reply Card

Longer life

. . . for V-belts: *Bulletin 02X6234C* describes the different types of V-belts, how to select the proper one and how to install all of them. Listed are seven steps for the correct installation of V-belts, and eight common causes for their destruction. Allis-Chalmers Manufacturing Co., Milwaukee 1, Wisc.

Circle No. 39 on Reply Card

Proportioning pumps

. . . for precision metering: *Bulletin No. 602* covers the details of mechanical and hydraulic drive pumps, which can be used for the blending of many chemicals. Flow can vary from .05 to 34 gal/hr on the "U" type and from 13 to 730 gal/hr on the "K" type. Hills-McCanna Co., 2448 West Nelson St., Chicago 18, Ill.

Circle No. 40 on Reply Card

Wet processing equipment

. . . for refining slurries and blending and homogenizing viscous materials: *Catalog No. 600* is a 24-page description of the Eppenbach line of wet mixing and blending units. Colloid mills, high speed homogenizers and mixers, and accessory vessels for using these units are described and specified. Gifford-Wood Co., Graybar Building, New York 17, N. Y.

Circle No. 41 on Reply Card

Reference manuals

. . . on galvanic protection: these are reports of a 6-year project investigating the proper use of zinc as a galvanic anode to protect iron and steel

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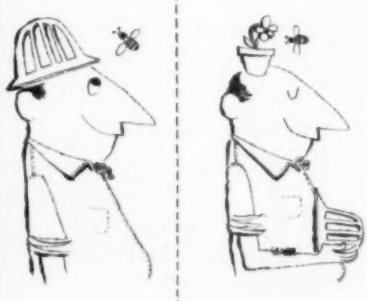

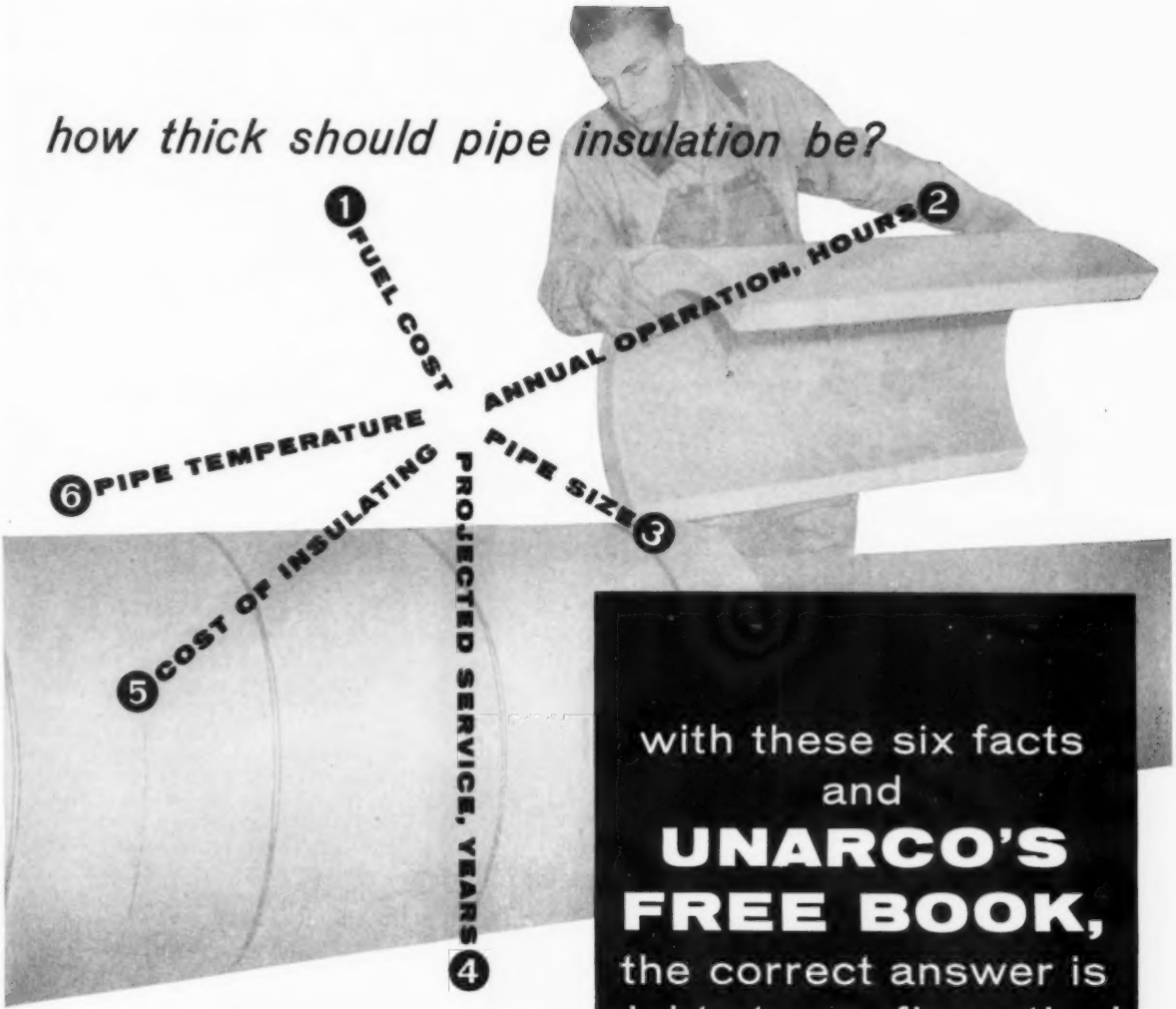

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the correct answer is right at your fingertips!

Too much insulation can be just as wasteful as *too little*. Every insulation-dollar you spend, which is not amortized by fuel-savings, represents needless investment. But, until UNARCO developed "J" Factor Tables, engineers had no *easy way* to determine the most economical thickness.

With today's "J" Factor Tables—and knowing the cost of fuel, hours of operation, life expectancy of the installation, pipe sizes and temperatures, and the cost of insulation, installed—it's merely a matter of ready reference to pick out the right thickness to use.

Time-saving UNARCO "J" Factor Tables should be in every engineer's file. Everything is condensed into five simple charts covering pipe temperatures up to 1200° F. and insulation thicknesses from 1" to 6½". This, and much other pertinent data, is included in UNARCO'S free new 40-page book.

If you are involved in the design or operation of power plants, atomic developments, petroleum or chemical processing, or any other matter requiring conservation of BTUs, mail the coupon today.

UNARCO®

All-round dependability, high thermal efficiency, and unmatched ease of installation, make single-layer UNIBESTOS the world's finest pipe insulation.

UNION ASBESTOS & RUBBER COMPANY
1111 West Perry Street, Bloomington, Illinois

Please send me your free 40-page Insulation Booklet containing "J" Factor Tables.

Individual_____

Company_____

Street_____

City, Zone, State_____

(To obtain more data on advertised products see page 280)

Thirty Million B. T. U. CAPACITY

NIAGARA Aero HEAT EXCHANGER

Cooling in Chemical Processes with Precise Control of Temperature

The NIAGARA Aero HEAT EXCHANGER cools liquids and gases by evaporative cooling with atmospheric air, removing the heat at the rate of input, controlling temperature precisely. You save 95% of cost of cooling water; you make great savings in pumping, piping, power; quickly recover your installation cost.

You can cool and hold accurately the temperature of all fluids, air and gases, water, oils, solutions, chemical intermediates, coolants for mechanical, electrical and thermal processes. You obtain closed system cooling free from dirt. You solve all the problems of water availability, quality or temperature.

In CHEMICAL PROCESSES this is successfully used in cooling liquids and gases, chemical reactions, condensing distillations and reflux cooling.

Write for complete information; ask for Bulletins 120 and 124. Address Dept. PP-5.

NIAGARA BLOWER COMPANY

405 Lexington Ave. New York 17, N. Y.

District Engineers in Principal Cities of United States and Canada

from corrosion. *Zinc as a Galvanic Anode Underground* is a 40-page manual on the details of designing galvanic systems to protect underground pipes, tanks and tower footings. *Zinc as a Galvanic Anode Underwater* is a 16-page report on cathodic protection of ships, water storage tanks, piling and traveling water screens. Both manuals are available from American Zinc Institute, Inc., 60 East 42nd St., New York 17, N. Y.

Circle No. 42 on Reply Card

Portable drum hoists

. . . operate on air, gasoline or electricity: *Bulletin 76-X* carries descriptions and specifications for the Joy line of hoists. Ranging in size from 0.9 to 15 H.P., these hoists have lifting capacities from 750 to 5000 lbs at rope speeds up to 125 fpm. Wire rope capacities range from 200 to 1500 ft. Joy Manufacturing Co., Oliver Building, Pittsburgh 22, Pa.

Circle No. 43 on Reply Card

Cleaning equipment

. . . by chemical methods: *Service Report B4885* describes how to salvage and clean old equipment in one simple soaking operation. New detergents can remove rust, grease and old paint from equipment once considered unsalvageable. No brushing, scraping or sandblasting is required. Oakite Products, Inc., 19 Rector St., New York 6, N. Y.

Circle No. 44 on Reply Card

Research facilities

. . . of the Selas Corporation of America: *An Approach to Interpretive Research* is a 24-page bulletin describing the research laboratory of this company located in Dresher, Penn. Described and pictured are the facilities which are used in developing new methods for heat processing of fluids. Selas Corporation of America, Dresher, Pa.

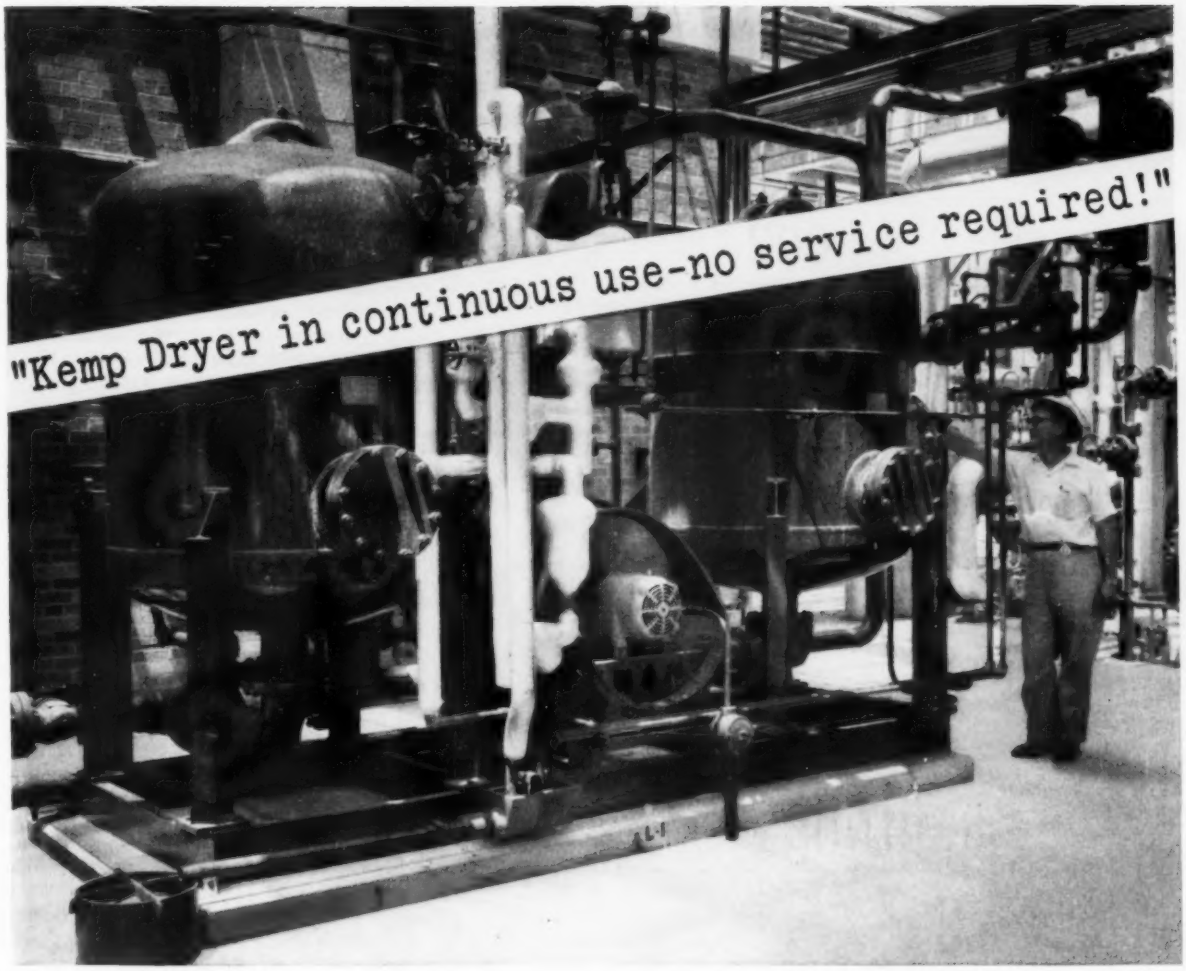
Circle No. 45 on Reply Card

Did you miss these?

The following items, reviewed originally in January, have aroused considerable interest among readers. They are repeated here briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Oil industry story

. . . written for popular appeal makes interesting reading for everyone: *The*



Cities Service Petroleum reports:

Kemp Dryer in continuous operation 7 days a week; has required no service or downtime!

To dry compressed air for instruments in a hydroformer unit at its refinery in Lake Charles, Louisiana, Cities Service Refining Corporation has installed a Kemp Model LC SE2 Air Dryer. Since January, 1955, it has served continuously—seven days a week—drying 1900 cubic feet of air per minute to a dew point of −10° F.

This fully automatic Kemp Dryer, reactivated every 12 hours (or 22,800 cubic feet of air), has so far required no down-time or service at all! And, according to Mr. Glendon L. Smith, Unit Engineer at Cities Service, there is practically no pressure drop from the entering pressure of 285 pounds . . . further indication of Kemp quality and efficiency.

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air, gases or liquids to sub-zero dew points at low cost, they are constructed of quality materials and embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the removal of water from air, gases or liquids, contact Kemp now. For complete facts and technical information, write for Bulletin No. D-100.

KEMP
OF BALTIMORE

DYNAMIC DRYERS

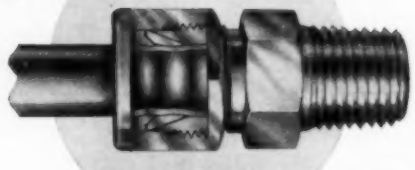
CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

THE C. M. KEMP MFG. CO.
405 East Oliver Street, Baltimore 2, Maryland

 (To obtain more data on advertised products see page 280)

Only
one
name
identifies
the
finest
in
fittings

Swagelok®



TUBE FITTINGS

There is a Swagelok Specialist in your area. For catalog, write Dept.

CRAWFORD FITTING COMPANY
884 East 140th Street • Cleveland 10, Ohio

What's New

Industry Nobody Really Knows is a 35-page report by Craig Thompson, a well known reporter, and is aimed at giving consumers of all petroleum products a realistic picture of the oil industry. The story includes personal sketches of typical men in the industry—the millionaire, the constant dry-holer, the successful service station operator, and others whose jobs depend on oil. A well-written and well-presented book, this story of oil is available from Gulf Oil Corporation, P. O. Box 1166, Pittsburgh 30, Pa.

Circle No. 46 on Reply Card

New dessicant

. . . has 19 times the water adsorption capacity of the best silica-type adsorbents. It also performs well at temperatures as high as 112°F.

Molecular Sieves have extremely small pores in their crystalline structure that exclude both refrigerant and oil molecules. This permits selective adsorption of water molecules on the surface of these crystalline aluminosilicates. The material will release the water of hydration when activated by heat, with little or no change in cystral structure.

This material has an adsorption capacity of 19 wt-% when used with a concentration of 10 ppm of residual water in Refrigerant-12, at a temperature of 140°F. It can be obtained in the form of hard, spherical pellets for use in refrigeration systems, adsorption units, or for effective drying in units located in small hot motor compartments. Linde Air Products Co., 30 East 42nd St., New York 17, N. Y.

Circle No. 47 on Reply Card

Iso-Kel isomerization

. . . uses a non-platinum catalyst for getting higher octanes from light naphthas. This new process produces two separate products from a mixed pentane-hexane stream: an isopentane stream of 104.9 research octane (with 3 cc TEL), and an isohexane stream of 89-92 research octane (with 3 cc TEL). The isopentane stream can be allocated for the super premium gasoline and the isohexane for the house brand.

When charging light naphtha, the combined streams have an overall yield of 97%, and an octane number of 96 research with 3 cc TEL. When charging natural gasoline, overall yield is 99 vol%, with a research octane of about 99.8 with 3 cc TEL.

Only one reactor, which operates in the presence of hydrogen, is needed

CLASSIFIED

DISPLAYED RATE

The advertising rate is $13.50 per inch for Equipment and Business Opportunity advertising appearing on other than a contract basis. Contract rates quoted on request.

Employment advertising rate is $13.50 per inch and is subject to Agency Commission.

INFORMATION:

BOX NUMBERS count one additional line in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

UNDISPLAYED RATE

$1.50 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (see ¶ on Box Numbers.)

POSITION WANTED. Undisplayed rate is one half of above rate, payable in advance.

PROPOSALS, $1.50 a line an insertion.

Send NEW ADVERTISEMENT to Classified Advertising Division, PETROLEUM PROCESSING, P.O. Box 12, N. Y. 36, N. Y.—SECTION CLOSES May 27th for the June issue.

DIRECTOR OF ENGINEERING

•

Are you a driving, intensely competent second or third ranking man in the engineering division of an old line pressure vessel company who is impatient to step into the top job *now*? If so, give us full particulars on yourself and we may have the opportunity for which you have been waiting.

•

P-5002 Petroleum Processing
520 N. Michigan Ave.,
Chicago 11, Ill.

REPLIES (Box No.): Address to office nearest you c/o This Publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Process Engineer with two to five years' experience in refinery process work to fill position in newly organized Refining Division Technical Section. Work is of broad nature covering selection of processing steps and economic evaluation of processes. Unusual opportunity for advancement. Will pay moving and transportation expense. Liberal retirement, savings, insurance and health plans. Location—Bartlesville, Oklahoma. Replies will be held in confidence. Send resume of experience and salary requirement to Industrial Relations Division, Cities Service Oil Company, Bartlesville, Oklahoma.

Need Engineers for Your Refinery .... Petrochemical Plant?

A solution to this problem can be obtained through an employment advertisement in our CLASSIFIED advertising section.

PETROLEUM PROCESSING
P.O. Box 12
New York 36, New York

WANTED TO BUY: SPENT CATALYST

containing

TUNGSTEN • • COBALT
VANADIUM • • NICKEL
MERCURY • • CHROME
MOLYBDENUM & PRECIOUS METALS

FRED H. LENWAY & CO., INC.
112 Market Street, San Francisco • Douglas 2-8560

STEEL PIPE & TUBING
• Chrome Moly • Carbon Moly • Heavy Walls
• Carbon Steel • Stainless • Large O.D.
Widest Range of Sizes & Specs in the U.S.
WRITE FOR STOCK LIST
MIDCONTINENT TUBE SERVICE, INC.
2308 Oakton St., Evanston, Ill. DA 8-4030

RETIREMENT

•

Are you an experienced engineer, draftsman, or checker nearing retirement age who is giving some thought to a move to a warmer climate? If so, we may have exactly what you are seeking in a Florida-type climate in one of the country's best fishing and hunting sections. No compulsory retirement age and many fringe benefits. Give full particulars, availability, income pattern, etc., to

•

Personnel Director
DeltaTank Manufacturing Co., Inc.
P. O. Box 1469
Baton Rouge, Louisiana

LIVE AND WORK IN THE LAND OF 10,000 LAKES

Our Expanding Independent Refinery, located in a Twin Cities suburban area has openings for

CHEMICAL ENGINEERS
MECHANICAL ENGINEERS

These positions offer challenging assignments and unusual opportunities for professional development in a medium sized, growing company. Excellent salaries, many employee benefits. Good living conditions, excellent schools and unsurpassed recreational facilities.

CALL OR WRITE
T. C. KNIGHT
Personnel Manager
NORTHWESTERN REFINING CO.
ST. PAUL PARK, MINNESOTA
Tel. GLenview 9-9771

Clark

FITS TO A "T"

★ LOW INITIAL COST
★ EASY TO INSTALL
★ LOW MAINTENANCE
★ MINIMUM INVENTORY

Ask Your Distributor For These CLARK Fluid Controls

Inverted Bucket Traps	Venting Traps	Pressure Regulators
Open Bucket Traps	Thermostatic Traps	Y-Type Strainers
Float Traps	Vacuum Traps	Pressure Reducing Valves

STANDARDIZE ON THE COMPLETE CLARK LINE

ASK YOUR DISTRIBUTOR OR WRITE DIRECT FOR FREE BROCHURES ON CLARK FLUID CONTROLS

THE Clark MANUFACTURING COMPANY
1832 East 38th St. • Cleveland 14, Ohio

for the vapor-phase process. There are no corrosive elements in the system and operating conditions are less severe than those for reforming heavy naphtha. A payout time of about 19 months is anticipated in the case of a 3100 b/d Iso-Kel unit in a 50,000 b/d refinery. M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y.

Circle No. 48 on Reply Card

Operation manual

. . . for electrical controls. *Manual GEA-6372* is a 32-page illustrated publication that explains how and where to use manual starters, magnetic starters, push buttons, relays, limit switches, float switches and other types of general purpose electrical controls. General Electric Co., Schenectady 5, N. Y.

Circle No. 49 on Reply Card

Corrosion detected

. . . in michoinches by electric probe. The Corrosometer measures the progress of corrosion by measuring the loss of metal probe directly in microinches of penetration into the metal. The probe can either be immersed in a corrosive solution for instantaneous reading, or mounted permanently in the suspected environment for continuous readings.

This method has several advantages. Rapid and direct readings can be made within 30 sec; no shutdown is needed to retrieve metal specimens; measurements can be made in inaccessible spots by using several hundred feet of cable from the probe to the meter; and accumulated corrosion products do not effect measurements.

Three types of Corrosometers are available, a portable unit for field or laboratory use, one for use wherever AC power is available, and one which automatically records. Crest Instrument Co., 11808 S. Bloomfield, Santa Fe Springs, Calif.

Circle No. 50 on Reply Card

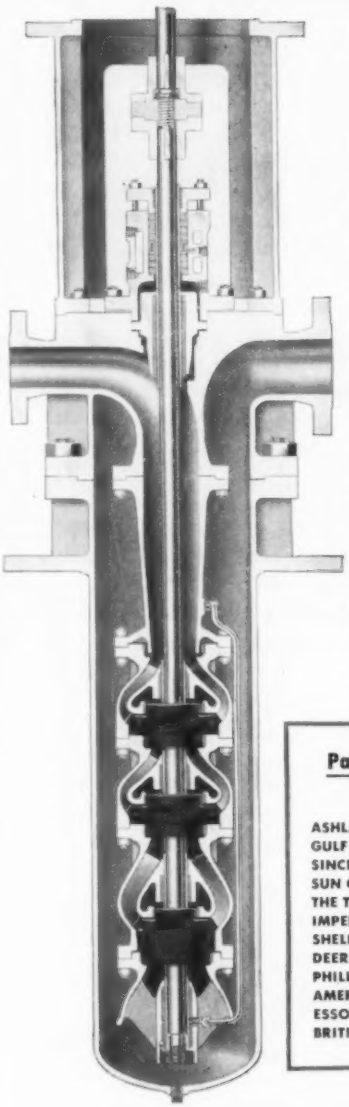
Digital computing

. . . and how to understand its language: a booklet titled *Symbolic Logic, Binary Calculation and 3C-PACs* is a primer on digital computation that should help clarify the important rudiments of this new tool. The booklet describes the simple rules of symbolic logic, showing how most of the calculations are based on a system of binary, rather than decimal, numbers. Computer Control Co., Inc., 92 Broad St., Wellesley 57, Mass.

Circle No. 51 on Reply Card

(To obtain more data on advertised products see page 280)

NEW! Bingham VCP VERTICAL PUMP FOR LOW NPSH



ALL WORKING PARTS ACCESSIBLE WITH BOTTOM DISMANTLING

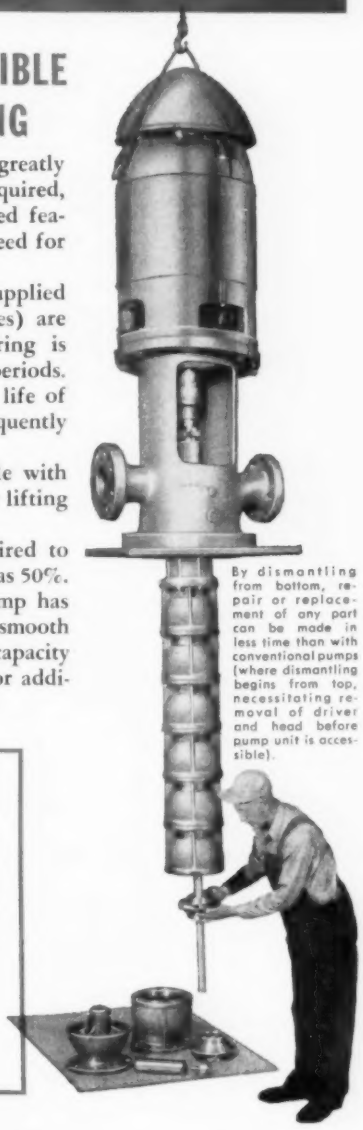
Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced features which minimize maintenance, reducing need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by pumpage. Bottom bearing is lubricated, even if pump runs dry for short periods. This *dependable* lubrication greatly prolongs life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

All working parts of pump easily accessible with bottom dismantling. One man can service after lifting pump from well.

Various operators estimate that time required to reach working parts has been reduced as much as 50%.

Wherever installed, the Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information.



By dismantling from bottom, repair or replacement of any part can be made in less time than with conventional pumps (where dismantling begins from top, necessitating removal of driver and head before pump unit is accessible).

Partial list of major oil companies with Bingham "VCP" Pumps in operation or on order:

ASHLAND OIL & REFINING CO.	LAKEHEAD PIPE LINE CO.
GULF OIL CORPORATION	CREOLE PETROLEUM CO.
SINCLAIR OIL & REFINING CO.	HUMBLE OIL COMPANY
SUN OIL COMPANY	STANDARD OIL CO. OF INDIANA
THE TEXAS COMPANY	CHEMICAL CONSTRUCTION CO.
IMPERIAL OIL CO., LTD.	CHAMPLIN REFINING CO.
SHELL OIL COMPANY	PACIFIC GAS & ELECTRIC CO.
DEERE & COMPANY	SOCONY MOBIL
PHILLIPS PETROLEUM CO.	AEROJET GENERAL CORP.
AMERICAN CYANAMIDE CO.	GREAT LAKES PIPE LINE CO.
ESSO-STANDARD OIL OF N. J.	KANEB PIPE LINE
BRITISH AMERICAN OIL CO., LTD.	BUCKEYE PIPE LINE CO.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

General Offices: **2800 N. W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B. C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.
CHICAGO, ILL.
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NEW ORLEANS, LA.
NEW YORK CITY, N. Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

Fertilize your own grass . . .

Solving the Technical Manpower Shortage—No. 3 in a series

TO carry out increased research and development programs, the petroleum processing industry expects to need 33% more scientists and engineers by 1960 than it did in 1956. Industry in general sees its needs up 23%. These startling figures were developed in the 10th Annual McGraw-Hill Survey of Business Plans, completed just last month.

Where is industry in general and the petroleum industry in particular going to find these additional technical personnel?

It is PETROLEUM PROCESSING's firm belief, as propounded for the past two issues on this page, that a good many of them are already on the job—and that the way to "find" them is to "keep" them, to prevent them from wandering off to other companies and even to other fields of endeavor.

One way to keep them, of course, is by the level of salaries—particularly for the older, experienced fellows who have been with you 10 or 15 years. In plain English, pay them enough to make them feel it is worthwhile staying with you, to keep them from feeling that they are not being treated fairly when they hear of starting salaries of $450 a month for fresh graduates.

Money isn't everything, fortunately, and there are other ways in which you can "reward" your technical personnel and keep them on your staff.

Recognize their contributions

One of the ways which has been suggested is to give your engineers and scientists more recognition for the contributions they are making to our economy. As Dr. William F. Ryan, president of ASME, recently remarked: "We live in the Age of Technology—the Age of the Engineer—but very few people know of the immense achievements of this professional group."

Give them public recognition—in your advertising, in your publicity, in your own publications. Give them recognition for patents and for development work, for the ideas they contribute to the improvement of your business and your products. Deal in specifics, not in generalities. Talk about "real" technical people on your staff; name names, show faces.

Recognize their professional stature

Another way to reward your engineers and scientists is to recognize that they are members of a profession, and to treat them as such. Deal with them as individuals, not as a mass of people.

Provide them with time and facilities for research and study, for reading and writing. Encourage them to belong to their professional societies, to attend and participate in technical meetings and symposiums—even to the extent of paying membership fees and travel expenses.

Sponsor technical meetings of your own people—and invite outside authorities to address them. Make arrangements for organized refresher courses to provide training in new developments.

Upgrade their jobs

A common complaint of technical people is that they too frequently are assigned jobs below their technical competence, jobs which are routine in nature and require little skill. Provide relief from this sort of work by giving it to technicians and clerks. Don't make bottle washers and typists out of scientists and engineers.

Rotate your technical men on various jobs—not at random but as part of an organized program of training and promotion. Let them know what the prospects are for people of their caliber in your organization, so they don't feel they are dead-ended.

Consider your top technical people as part of your management team. Ask their advice on decisions to be made—and keep them informed of what your decisions are.

* * *

Some of these things are already being done by some companies—by the ones who have little trouble keeping their technical staffs intact. But more of it needs to be done by more companies if we are to keep our technical manpower supply from being weakened by attrition.

What it boils down to is a program of making your pasture more attractive than your competitors, of fertilizing your lawn so the grass is greener on your side of the fence.

UNDER ONE ROOF!

"One-Stop Shopping" for Your Laboratory Chemical Needs at BAKER & ADAMSON

INORGANIC REAGENTS

The most complete, most preferred line in the country. B&A offers over 1,000 high-purity reagents to meet your every need. Outstanding for packaging, too!

"C.P." ACIDS

Widest possible selection from America's pioneer producer. More than 50 "C.P." Acids are available in all preferred grades and strengths to fill every laboratory requirement.

RADIO-CHEMICALS

B&A's extensive line includes organic and inorganic radioisotopes, including Carbon-14 labeled compounds and deuterated compounds.

RARE EARTHS

B&A regularly offers over 30 rare earths in experimental and commercial quantities. Others available on request.

ORGANIC CHEMICALS

The complete line of Eastman Organic Chemicals as listed by Eastman Kodak Company is always available from B&A.

BIOLOGICAL STAINS & INDICATORS

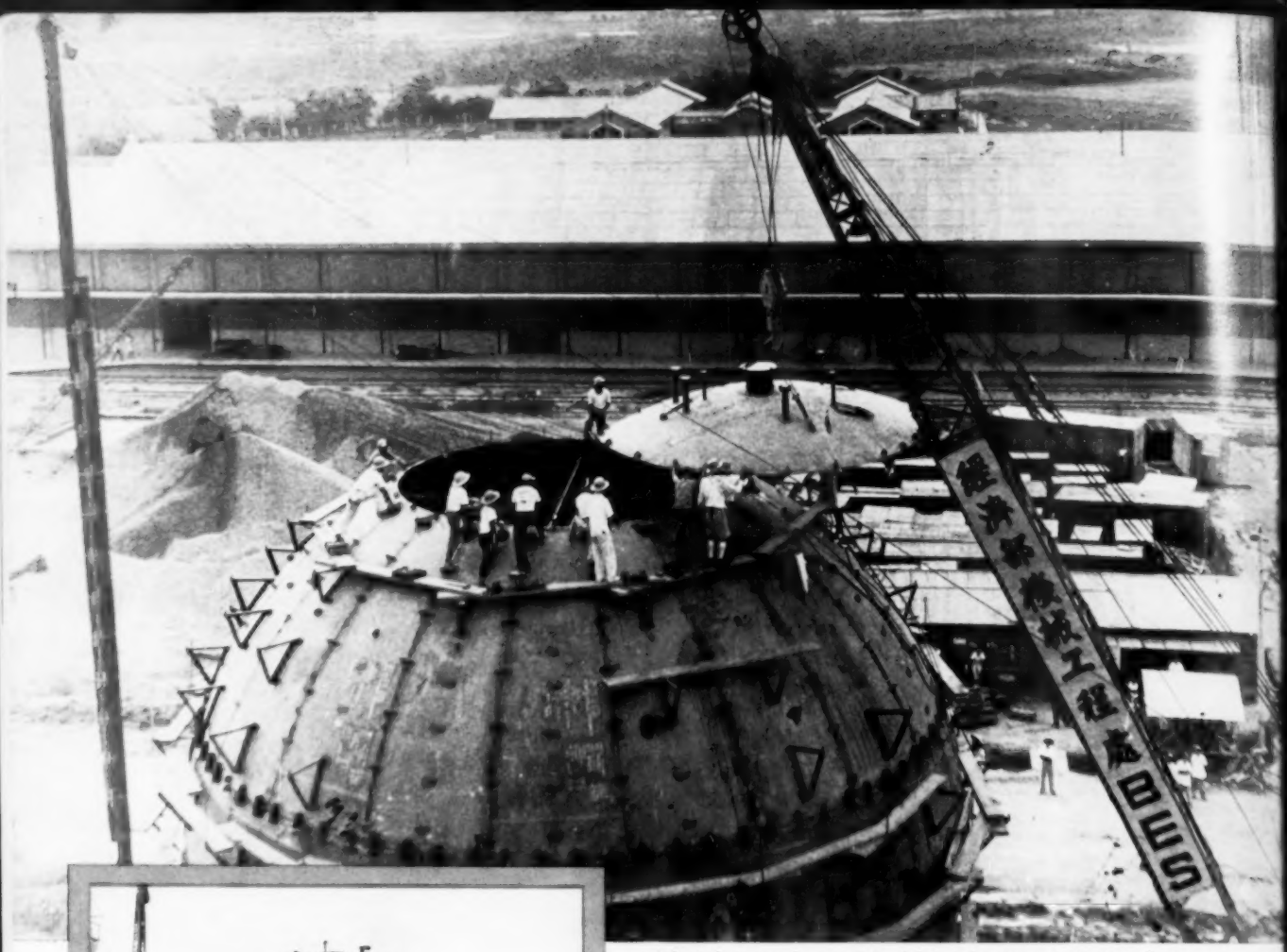
And, to "round out" its service, B&A provides the full line of "National Quality" Stains and Indicators of Allied Chemical's National Aniline Division.

✓ All readily available from B & A's coast-to-coast chain of distributing stations. Simplify your "shopping"! Make Baker & Adamson your convenient, dependable, "one-stop" source for all your laboratory chemical needs.

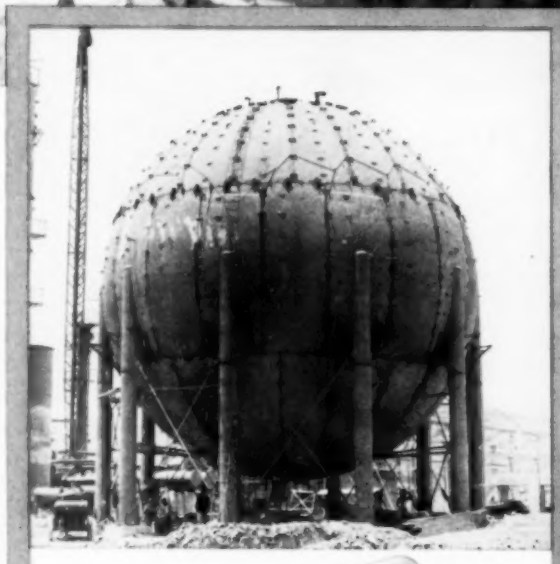
BAKER & ADAMSON®
Laboratory Reagents
GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

GC Allied Chemical

Offices Albany* • Atlanta • Baltimore* • Birmingham* • Boston* • Bridgeport* • Buffalo* • Charlotte* • Chicago* • Cleveland* • Denver* • Detroit* • Houston* Jacksonville • Kalamazoo • Los Angeles* • Milwaukee • Minneapolis • New York* • Philadelphia* • Pittsburgh* • Providence* • St. Louis* • San Francisco* Seattle • Kennewick* and Yakima (Wash.) In Canada: The Nichols Chemical Company, Limited • Montreal* • Toronto* • Vancouver* *Complete stocks carried here.



Spherical storage for ammonia, fabricated in Wyatt's Houston plant and erected in Taiwan (Formosa).



Wyatt's

HOUSTON-DALLAS-NEW YORK-TULSA

One Word...

----- ONE MEANING

To each country
One Word—One Lettering

Except . . .

In Every Country
In Every Language

WYATT'S spells QUALITY
In Plate Fabrication

FABRICATORS AND ERECTORS SINCE 1913

Plastics Resist Corrosion

CONSULT WYATT'S PLASTICS, INC.
ABOUT PROCESSING APPLICATIONS